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A MONOGRAPH OF THE HELICOSPOROUS FUNGI IMPERFECTI

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The group of Fungi Imperfecti characterized by helical spores, a group for the most part consisting of saprophytes which obtain their nourishment from decaying bark or wood, but also comprising a few members which are parasitic on phanerogams has been known for over a hundred years, the first species having been described by Link[1] in 1809.

The pioneers in the study of this group of fungi were chiefly concerned in describing numerous new species and establishing a number of genera to accommodate them. With the lack of adequate descriptions and delimitations of these, however, the increase in number resulted in confusion, to alleviate which various artificial classifications were proposed. Saccardo's system of classification is perhaps the most outstanding and most used. It was a step in advance but failed in some respects. To name an important source of confusion, one has only to consider two of the families of the Hyphomycetales, the Mucedinaceae and the Dematiaceae, which are separated, primarily, on the color of the spores and conidiophores. There are several helicosporous species which are transitional between these two families. In the genus *Helicoon*, for example, *Helicoon Richonis* is characterized by having fuscous spores and very short conidiophores, *H. auratum* by fuscous conidiophores and golden-yellow spores, *H. fuscosporum* by hyaline conidiophores and fuscous spores which are nearly hyaline when immature, and *H. farinosum* and *H. sessile* by entirely hyaline

[1] Link, H. F. Observationes in ordines plantarum naturales. Ges. Naturforsch. Freunde z. Berlin Mag. 3: 21. *pl. 1, fig. 35.* 1809.

conidiophores and conidia. All of these species, however, would be placed either in the Dematiaceae or Mucedinaceae, according to the Saccardan system. The system is not entirely to blame for the multiplication of names. The authors of the species should also be taken to task, since many of the early descriptions are so brief that it is next to impossible for the taxonomist to obtain anything but the haziest idea of a number of species, not only in this group but also in other groups of the Imperfecti. Often there are subtle distinctions in form that cannot be depicted except by drawings of the conidiophores or spores, yet frequently one or the other, or both, are omitted. Hence more doubt and more superfluous names add to the confusion which could be avoided easily by insisting that accurate illustrations should accompany the original description in order to validate the name of any microscopic fungus.

The aim of this paper, therefore, is to arrange the species in an orderly sequence with ample descriptions and illustrations, to relate where possible the sexual and asexual stages in the life history of the organisms, and to supplement these phases of the work with a comparative study of certain species in their development and biological reactions in culture by modern methods. For this reason the paper is divided into two parts,—the first part to deal with the study of the fungi in culture, the second to cover the taxonomy of the group.

Historical

The earlier workers in this group, aside from describing new species, covered to some extent the connection between the conidial forms and their perfect stages and a study of the course of development of the former. Handicapped as they were by their scanty facilities, the first writers made no efforts to obtain pure cultures. Hence there arose faulty ideas as to the nature of the helical conidia. Corda,[1] describing *Helicomyces aureus* as a new species, declared that the helical spores were parasitic on the sterile hairs of *Sphaeria exilis*, and three years later[2] he found them on what he thought were the sterile conidiophores of *Doratomyces olivaceus*. It seems much more probable, however, that these ster-

[1] Corda, A. C. I. Icones fungorum 1: 9, 15. 1837.
[2] Corda, A. C. I. Flore illust. Mucéd. d'Europe, pp. 29–30. 1840.

ile hairs of *Sphaeria* and of *Doratomyces* are in reality the conidiophores of *Helicomyces aureus*. Hence he unknowingly was the first to indicate connections between the imperfect stage, *Helicomyces*, and a perithecial condition. This was followed by further work on possible relations between the perfect and imperfect stages. Constantin,[1] in 1888, reviewing the genus *Helicosporium*, previously established by Nees von Esenbeck,[2] asserted that these forms were the conidial stages of *Crucibulum* and *Cyathus*, but gave no evidence to support his beliefs, which, in view of all subsequent work, appear to be without basis. The only instance that might possibly be interpreted as evidence for connections between the helicosporous forms and the Basidiomycetes is the occurrence of very small helical sporidia observed by Brefeld[3] to be produced on the germination of the basidiospores of certain species of *Exidia* and *Auricularia*, but they, in our modern conception of the nature of these spores, cannot be considered as homologous with the helical spores of the Fungi Imperfecti. Perhaps the first definite statement of connections between the Helicosporeae and a perfect stage was made by Plowright and Phillips[4] when they described *Sphaeria helicoma*, the conidia of which they state were similar to those of *Helicoma*, and emphasized by their choice of the specific name their belief in the interrelationship of the two forms. Cooke[5] expressed his doubt of this relationship, since he had also found in connection with the Sphaeriae other imperfect stages, such as *Helminthosporium* and *Monotospora*. Saccardo,[6] at a later date, accepted Plowright's idea and published not only his species but also Cooke's species of *Sphaeria* under the new names of *Lasiosphaeria helicoma* (P. & P.) Sacc. and *Chaetosphaeria parvicapsa* (Cke.) Sacc. and as such these were published and illustrated by Berlese.[7] More recently, in 1905, von

[1] Constantin, J. Les mucédinées simples. p. 101. 1888.

[2] Nees von Esenbeck, T. F. L. Das System der Pilze und Schwämme. p. 63. 1817.

[3] Brefeld, O. Untersuchungen aus dem Gesammtgebiete der Mykologie **7**: 69–94. 1888.

[4] Plowright, C. B. & F. L. S. Phillips. New or rare British fungi. Grevillea **6**: 26. 1878.

[5] Cooke, M. C. On black moulds. Quekett Microsc. Soc. Jour. **4**: 246–273. 1877.

[6] Saccardo, P. A. Sylloge fungorum **2**: 94, 192, 195. 1883.

[7] Berlese, A. N. Icones fungorum **1**: 27. *pl. 17.* 1890; 112. *pl. 115.* 1892.

Höhnel[1] published the new species *Helicosporium phragmites* which he says was "in Gesellschaft von *Acanthostigmella genuflexa* n. g. et sp., das vielleicht dazu gehört." This, one of the most recent statements indicating such relationships, is based on the mere occurrence of the imperfect and perfect stages together and emphasizes the necessity of establishing such relationships by exact studies in pure culture, for it would seem that by so doing a more natural line of division of the groups of the simple Sphaeriae might be arrived at, thus doing away with many of the unsatisfactory characters that are so often used in their identification.

The study of the imperfect forms in culture, on the whole, has been scanty. The first attempt at cultural studies was that of Zalewski,[2] who, in 1888, finding the unique spores of *Clathrosphaera spirifera*, carried on a series of experiments, not, however, in pure culture. During the course of these, as one of the accessory spore forms, he described a *Helicodendron* type of asexual spore, thus in the same year as Constantin announcing polymorphism in the Helicosporeae.

Four years later, Matruchot[3] made a study of the course of development of *Helicosporium lumbricoides* and reported as connected with the helical type, three additional spore forms,—a *Stemphylium*, a *Coniothecium*, and a "sclerote pedicelée." Of these the *Coniothecium* stage was the only one not shown by the drawing to be connected with the helical spores, but was, on the other hand, the only form that gave rise to them in culture. This stage, however, should not, it seems to the writer, be considered a separate form but rather a senile condition of the vegetative hyphae in which the cells have become swollen and colored, and deep constrictions have appeared at the septa,—a condition relatively common in cultures of this group. The *Stemphylium* type of spore, Matruchot states, was found but once, and then in a hanging-drop culture supplied with alkaline urine that was constantly renewed. It was said to be borne on the same hyphae as the helical spore, and was so illustrated; yet when it was transferred

[1] von Höhnel, F. Mycologische Fragmente. Ann. Myc. 3: 338. 1905.

[2] Zalewski, A Przyczynki do zycioznawstwa grzybow. Rozpraw Spraw. Wydz. matem. przyr. Akad. Krakau 18: 153–191. 7 *pl* 1888.

[3] Matruchot, L. Recherches sur le développement de quelques Mucédinées, pp. 5–37. *pl. 1–2.* 1892.

back to normal environmental conditions it failed to give rise to the coiled conidia of *Helicosporium* and instead continued as a strain of *Stemphylium*. It seems to the writer, therefore, that although the "sclerote pedicelée" and the so-called *Coniothecium* are a part of the polymorphic life history of the asexual stage, the *Stemphylium* was a contamination that entered the culture during the renewal of the medium.

Investigations in which pure single-spore cultures were employed are those of Rand,[1] who in studying in detail the pathology and life history of *Helicosporium nymphearum* Rand, found that sclerotial bodies were produced, but from these, by none of the methods employed, was he able to obtain the perfect stage. This species, because of its parasitism on phanerogams and more especially because of the toruloid nature of its spores, should be placed in the genus *Gyroceras*, a combination made in the second part of this paper. More recently, Killian,[2] during the course of his investigations of the life history of *Gyroceras Celtidis*, has found in connection therewith a pycnidial, a sclerotial, and a perithecial stage, the last having previously been described as *Sphaerella Celtidis* Passerini. Of the sclerotial stage, Killian concludes that, although the exact nature is unknown, it appears to be an abortive perithecium. Such may be the explanation of the sclerotia found in culture by Rand.

From this brief survey, it is obvious that our knowledge of the group of helicosporous Fungi Imperfecti is in many respects meager. Is it evident also that there is need especially of comparative studies of representative species in pure culture to serve as a sound basis for classification, to extend our knowledge of the life history and biology of the group, and also where possible to correlate the perfect and imperfect stages.

Acknowledgments

This paper was begun while the writer was a graduate student in the Laboratory of Cryptogamic Botany at Harvard University, and was completed at the Missouri Botanical Garden. The

[1] Rand, F. V. Leafspot-rot of pond lilies caused by *Helicosporium nymphearum*. Jour. Agr. Res. 8: 219–232. *pl. 69–70.* 1921.

[2] Killian, C. Le Gyroceras Celtidis Mont. et Ces. parasite du Celtis australis L. Soc. d'Hist. nat. Afrique Nord, Bull. 60: 274–281. 1925.

experimental studies, appearing here in a condensed form, and the taxonomy of those species used were submitted as a thesis in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Harvard University. In addition to this, almost all of the bibliographical and much of the taxonomic work was accomplished at the Farlow Herbarium of the same institution.

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Part I. Studies of the Fungi in Culture

Materials and Methods

These studies were made with pure cultures isolated from collections made by the writer in Canton and Cambridge, Massachusetts, and supplemented to some extent by comparisons with dried material in the writer's collection, in the von Höhnel herbarium, and in the herbarium of Dr. Thaxter.

Because of their inconspicuousness in some cases, and their none too frequent occurrence in others, these organisms proved rather difficult to gather together for a comparative study. After some field work, however, it became possible to recognize likely habitats, which are, for the most part, the moist under-side of the bark of limbs of deciduous trees that have fallen to the ground in shaded glens, at the borders of brooks or swamps, or in moist fields,—in general, wherever there is a fair degree of moisture the year round. Bark is most suitable for the growth of the fungi when it is somewhat weathered, and when it has just separated from fallen logs it is especially likely to bear the organisms in question. Wood also frequently serves as a substratum, chiefly when it is moist and just beginning to soften with decay.

Isolation of the fungi of this group gave considerable trouble at first. Because of the size of the spores, the somewhat gelatinous sheath that they secrete, and the presence of other fungi among or near the colonies, there is an abundance of foreign spores that cling to the ones desired and make the simpler methods of isolation of doubtful, or at least uncertain, value. Of the methods tried, the poured-plate method of the bacteriologist proved of little value in the present researches; the Barber spore picker, although used to a limited extent, was tedious, and when the spores were isolated not only were they often contaminated with bacteria but in some species a large percentage failed to germinate. The other method employed while in the field was simple though prolonged. The spores were picked off, under a hand lens, with a sterile platinum needle and transferred to an acid medium where they were allowed to germinate. As the hyphae from the germinating spores grew clear of the bacterial colony they were transferred to a more favorable medium. Undoubtedly the best procedure was Wehmeyer's[1] modification of the sprayed-spore method used by Kauffman. The spores were transferred to 10 cc. of sterile water, 2 or 3 drops of 10 per cent lactic acid added, and then after a thorough shaking to distribute the spores a quantity of the solution was taken up in a sterile pipette and sprayed on an agar plate which was then tilted back and forth until there was an even

[1] Wehmeyer, L. E. The imperfect stage of some higher Pyrenomycetes obtained in culture. Mich. Acad. Sci. Arts & Letters, Papers 3: 245–266. 1923.

distribution. The spores were cut out singly under the microscope as they began to germinate. This treatment not only washed out the larger contaminating spores from the helical ones, but the addition of acid also inhibited the growth of bacteria.

Various agars, such as corn-meal infusion, carrot, chestnut bark, and potato-dextrose agars, were used for general culture work. While they were all satisfactory for this, chestnut-bark infusion agar, made by allowing 250 grams of the bark to stand a week in a litre of water, straining off the liquid and then adding 4 per cent of agar, made a favorable acid medium for isolation, and was almost exclusively used for that purpose. Potato-dextrose agar was an easily available and readily prepared medium that was of value for cultural work and, because of its transparency, was utilized when van Tieghem cells were employed. In addition to these, Pethybridge's rolled-oat agar, as used by Wehmeyer, was found to be an exceedingly good substratum for studying the natural behavior of the fungi on artificial media. In fact, this is the only one on which nearly all species showed normal color and conidium production. For hydrogen-ion work, Pfeffer's solution, as prepared by Gillespie,[1] with the addition of 4 per cent agar, was used; the solution being made acid by citric acid, and basic by NaOH. The solutions were tested by the colorimetric method before and after sterilization. To insure uniformity of material, a large amount of medium was made up at one time. A similar procedure was followed when Schmitz's[2] solution with 4 per cent agar was prepared and tests made with maltose, xylose, wheat starch, pectin, cellulose, and asparagin. The pectin was prepared by the method advocated by Baxter,[3] and the cellulose by that worked out by Northrup.[4] In this connection it should be emphasized that the $FeCl_3$ used as a solvent for cotton should be maintained at a temperature just high enough to keep it molten; should this be

[1] Gillespie, L. J. The growth of potato scab organism at various hydrogen-ion concentrations as related to the comparative freedom of acid soils from the potato scab. Phytopath. 8:257–269. 1918.

[2] Schmitz, H. Relation of bacteria to cellulose fermentation induced by fungi with special reference to the decay of wood. Mo. Bot. Gard. Ann. 6: 93–136. 1919.

[3] Baxter, D. V. The biology and pathology of some hardwood rotting fungi. Am. Jour. Bot. 12: 522–554. 1925.

[4] Northrup, Zae. A new method of preparing cellulose for cellulose agar. Abstr. Bact. 3: 7. 1919.

exceeded and the solution boil, the resulting precipitate will be charred.

Observations occasionally were made from material growing in test-tubes or in 250-cc. Pyrex flasks. Especially was this done when experiments were to run for a considerable length of time, but van Tieghem cells and Petri dishes proved most convenient,—the former when the earlier stages of the development of the fungus or the germination of spores was being examined, the latter when experiments in which the growth of a colony was to be measured, as in the study of the effect of hydrogen-ion concentration, temperature, and of different organic substances. In such cases, measurements were made radially from the edge of the inoculum to the periphery of the colony. The cultures were allowed to grow a week or more before the first measurements were taken. After this they were again allowed to grow for a varying length of time, at the end of which a second series of measurements was made. The rate of growth was then determined by dividing the difference in the amount of radial growth by the number of days elapsed. By following this procedure, the effects of nutrient material on the fungus mycelium and also on the substratum transferred therewith were avoided, and the availability of the carbohydrates in the media to be tested was more definitely shown.

LIFE HISTORIES

The group of helicosporous Fungi Imperfecti is one including 11 genera and comprising over 75 species. Of these, only the species included in the Dematiaceae and Mucedinaceae will be considered here. Of the 7 genera of the above-mentioned families, representatives of 5 have been cultured and compared as to their life history and relations to environment. These are *Helicoma Mülleri*, *H. Curtisii*, *Helicosporium aureum*, *H. gracile*, *Helicomyces scandens*, *Helicodendron tubulosum*, *H. triglitziensis*, and *Helicoon sessile*.

The life histories of the representatives studied in this part of the paper were most conveniently worked out by following their growth in van Tieghem cells, supplemented by observation from tube cultures and from freshly collected material.

Germination of spores takes place readily either in water or on

a nutrient substratum. The one requirement, as will be seen later, is that the relative humidity be sufficiently high. At first there is an increase in the turgor of the spore, resulting shortly in the rupture of a sheath or exospore (pl. 14, fig. 7; pl. 30, figs. 1–2). This exospore, although not previously reported so far as the writer is aware, has been observed to crack off in all species studied except *Helicoon sessile*, *Helicodendron tubulosum*, and *H. triglitziensis*. Often, although it is hyaline, it is quite pronounced, even on the ungerminated spores. In the case of *Helicosporium aureum* and *H. gracile*, when the exospores are cracked off, it is found that they are permeated with a yellow color characteristic of the spores of that species, and that the spore proper is hyaline.

Following the rupture of the exospore, germination tubes are produced. The spores of *Helicoma Mülleri*, *H. Curtisii*, and *Helicosporium gracile* typically begin to germinate merely by the elongation of their terminal cells, following which they arise from any of the central cells. With the remaining species, one or more of the central cells almost invariably germinate first, while the end cells remain inactive and at times fail to swell, thus appearing as dwarfed appendages to the neighboring inner cells. Although all the cells of a given spore are capable of germinating, it has never been observed by the writer that they do so, even though they may undergo swelling. Just what the function of these inactive cells may be cannot be stated definitely, yet there is a suggestion that they may serve as a reserve of nourishment for the more vigorous and more rapidly germinating ones.

Once the germ tube is formed, growth proceeds rapidly in most species, and shortly the hyphae begin to branch and anastomose. Later the hyphae of all species but *Helicodendron triglitziensis* and *Helicoon sessile* become some shade of brown. At first only one or two cells are colored but soon all the older parts of the colony become involved. At or just previous to the production of the pigment, the cells in or near the center of the colony swell between the septa, and a pseudoparenchymatous mat of swollen cells results, resembling that already described for *Helicodesmus*.[1]

[1] Linder, D. H. Observations on the life history of Helicodesmus. Am. Jour. Bot. 12: 259–269. 1925.

Helicosporium aureum, however, does not produce such a mat. Instead, several adjacent cells swell up, divide in various directions (pl. 14, figs. 5–6), and form a compact, darkened mass of cells that resemble perithecium initials. These later result in rounded perithecium-like bodies which on examination prove to be soft and sterile, remaining in that condition even after three months. It is quite possible that these bodies may represent the immature stages of the "Sphaeriae exilis" mentioned by Corda.

Helicoon sessile shows an interesting modification of the pseudoparenchymatous mat, if it can be so termed. The hyphae do not swell as did those of the other species. Instead, there is a tendency for the hyphae to grow parallel and close together to form flat strands, between the elements of which there are frequent fusions by means of lateral processes (pl. 26, fig. 15). Such strands, although having their origin in the center of the colony and in the deeper layers, are much more elaborate near the surface of the substratum, natural or artificial, or under conditions such as exist on the sides of the test-tubes above the agar where the available concentration of nourishment and moisture is relatively low. Under such circumstances, these strands apparently serve the purpose of transporting food material and of retaining moisture. Frequently, when single hyphae have become dry and have lost their turgidity, a liquid substance has been observed between the turgid elements of the strands.

When the conidiophores form, they may do so in two general fashions: They may arise merely as branches of surface or aerial mycelium from which they are distinguished with difficulty, or they may arise as somewhat differentiated and specialized branches of the mycelium in the substratum. The first type is characteristic of all but four of the species studied here. Upon this type of conidiophore the conidia are borne singly on teeth that are generally pleurogenous on the upper surface of the repent mycelium, but frequently they are acrogenous on short, erect, little-differentiated branches. The second type of conidiophore is characteristic of *Helicosporium aureum*, *H. gracile*, *Helicoma Curtisii*, and *H. Mülleri*. The differentiation is evident from the beginning. Two, three, or more adjacent cells of the creeping sterile hyphae swell, become colored, and send out erect branches that are concolorous

with the fuscous or subfuscous swollen cells of the vegetative hyphae. This branch, after elongation, is quite definitely a conidiophore, not merely a side branch of the repent or aerial mycelium. Such conidiophores after repeated spore formation may then commence to branch in a manner characteristic of the species.

Spore formation next takes place. A bud begins to form on the terminal cell of the conidiophore, or on the side if the species bears the spores pleurogenously. This bud or bulge elongates and shortly swells to the diameter of the mature filament, leaving a constriction at the base that becomes the tooth or sterigma. After reaching somewhat less than half the diameter of the eventual spore, the filament curves over and grows in two planes, or three planes in the case of *Helicoon* and *Helicodendron*. In *Helicosporium aureum* especially, and in other members of *Helicosporium* not considered in this part of the paper, the teeth show an interesting behavior. When first formed they are slender and cylindrical, but later, at the point of attachment to the conidiophore there is a swelling which develops into the hyaline bladder-like lateral projection on which more teeth are produced and more spores formed. In even older portions of the sporogenous area of the conidiophores, these projections may become so elongate, even slightly colored, as to have the appearance of a short lateral branch. Frequently in those species which produce their spores pleurogenously, many of the spores may be acrogenous at first. In *Helicoma Mülleri*, for example, the first spore is formed at the apex of the terminal cell. With the elongation of the terminal cell, a process that continues as the conidium reaches maturity, the first-formed conidium is pushed to one side and another spore is produced on the new apex of the conidiophore. When a single spore, or not rarely three or four spores, have been produced in this fashion on the terminal cell, a cross-wall is laid down above these spores, now lateral, and the process continues. Lateral conidia may also be produced on new or previously occupied sterigma of the lower cells, but when they are produced on previously occupied sterigma, those sterigma are usually branched (pl. 21, fig. 15).

Cultural studies with the species used in these experiments gave little evidence of polymorphism, although further evidence was constantly sought. The writer, using *Helicodendron tubulosum*,

the same species, so far as can be determined, studied by Zalewski, failed to find the long list of forms which that author published. Zalewski's experiments were repeated three or four times without success. While cultural experiments failed to strengthen the evidence for polymorphism in the species mentioned, in nature, very rarely, another type of spore is produced by *Helicosporium aureum*. It is quite different from the helical spore, being brownish and ovoid (pl. 14, fig. 3) and produced on the slightly colored tip of the conidiophore in the early stages of development. It is with hesitation that this form of spore is reported, since it has been found only once by the writer, although its occurrence was indicated more frequently by the blunt teeth, pleurogenously borne, just below the apex of the conidiophore. It may have been these spores that suggested to Corda that the helical spores were parasitic on *Doratomyces*. The "sclerote pedicelée" of Matruchot has been observed in herbarium material of *Helicosporium nematosporum* and *Helicoma proliferum* and is undoubtedly a part of the life history of these species.

RELATION BETWEEN PERITHECIAL AND CONIDIAL STAGES

During the course of these experiments, many methods were tried in the hope of producing the perfect or perithecial stage of these fungi: They were grown on different media, under different conditions of temperature and humidity, and strains from different localities and different natural substrata were contrasted, but these attempts were fruitless. However, in the course of collecting the different conidial forms, the writer was fortunate enough to find the perithecia of *Lasiosphaeria pezizula* growing in connection with *Helicoma Curtisii*. Single-spore cultures were made by Wehmeyer's method, as previously described, and the life history was followed in pure, single-spore culture, from the ascosporic to the conidial stage. The ascospores (pl. 21, figs. 3–5) whether hyaline, or deeply colored as they are at maturity, when transferred to a suitable moist medium, germinate after two or four days, or somewhat more slowly than the conidia. The two end cells invariably germinate first (pl. 21, fig. 6) and then are followed by the central cells, some of which may not send out hyphae. At the end of two weeks at laboratory temperature, the mycelium gave rise to the

conidia of *Helicoma Curtisii*, thus establishing the connections between the two forms. Although single-spore and single-ascus cultures have been maintained for five months on various media, as yet no perithecia have been produced. It is hoped, however, that further experimental work may yet make it possible to complete the cycle.

RELATION TO ENVIRONMENT

GROWTH ON ARTIFICIAL MEDIA

Helicoma Mülleri Cda. — *Helicoma Mülleri*, at best not a rapidly growing form, produces mycelium and spores very slowly on chestnut and carrot agars. It does, however, grow rather rapidly on potato-dextrose agar and rolled-oat agar, both of which support a vegetative growth similar to that found in nature. In respect to its nearly normal growth on potato agar, this fungus is unique among those studied,—the other species producing on this medium an abundance of aerial mycelium at the expense of spores.

When grown on Schmitz's solution agar to which maltose, wheat starch, xylose, pectin, cellulose, or asparagin have been added, growth, as is shown in table 1, is most rapid on xylose, followed in order by pectin, maltose, wheat starch, and cellulose, with very little or none on asparagin. The color of the colonies on

TABLE I

Medium	Av. growth in mm. after		Rate of growth per day	Relative per cent of sporulation
	12 days	20 days		
Maltose	1.8	4.1	.29	60
Wheat starch	1.0	4.3	.24	30
Pectin	2.0	5.3	.44	100
Xylose	1.8	5.5	.46	80
Cellulose	.37	2.8	.18	—
Asparagin	.00	.00	.00	—

these media also varied to some extent: on xylose, pectin, and starch, they were "Buckthorn Brown";[1] on maltose, "Cinnamon Brown"; and on cellulose they were nearly hyaline. There was also a pronounced "Mars Brown" discoloration in the medium when xylose and pectin were employed; wheat starch agar was

[1] Ridgway, R. Color standards and nomenclature. Washington, D. C., 1912, used where colors are in quotation marks.

less discolored, and the color present was confined to the immediate vicinity of the buried hyphae, while on maltose there was very little discoloration. Spore production was best on pectin and xylose, as is shown by the above table, and appears to be correlated to an extent with the coloration of the hyphae and the amount of discoloration in the agar. From the evidence presented, it appears that materials of the nature of pectin and xylose are important as sources of food material for the fungus, and that on the availability of these depends the ability of the fungus to dissolve cellulose and thus to penetrate the substratum of bark upon which the species is most frequently found.

Helicoma Curtisii Berk.—With the various organic materials used to test the availability of substances that might occur in the natural substrata, it was found (table II) that *Helicoma Curtisii* made the greatest growth on maltose, followed closely by xylose and pectin, and to a lesser degree by wheat starch, and cellulose.

TABLE II

Medium	Av. growth in mm., after		Rate of growth per day	Relative per cent of sporulation
	12 days	20 days		
Maltose	1.2	4.1	.36	—
Wheat starch	1.0	2.0	.12	—
Pectin	1.8	4.0	.27	50
Xylose	1.8	4.1	.29	100
Cellulose	.5	.5	.00	—
Asparagin	.41	.41	.00	—

On maltose, which vied with xylose and pectin as being the most favorable agar medium for vegetative growth, there was no sporulation, yet on the last two this did occur. On the media which were apparently most favorable for vegetative growth, the mycelium, unless masked by the presence of brownish conidiophores, was yellowish in color, a character manifested on all artificial substrata and apparently characteristic of this species in culture. It is interesting to note that, although this species grows more frequently on wood, cellulose is less available as a source of nourishment than it is for *H. Mülleri*. This may perhaps be explained by the fact that when the fungus does occur on wood, the hyphae are chiefly to be found in the wood rays, and it is possible that enough avail-

able carbohydrate material is still present to support growth. This seems quite plausible, especially since in those cases in which the writer has found it on wood, the hyphae have followed closely the zone vacated by the bark as it separated from the wood, where the soluble carbohydrates are less likely to have dissolved away.

Helicosporium aureum (Cda.) Linder.—Since this species grows chiefly on old coniferous boards, very rarely on bark, it is of interest to note its relation to the substratum. Longitudinal sections of a pine board, on which the fungus was growing luxuriantly in nature, show that the hyphae do not follow along the wood rays as do those of *Helicoma Curtisii*, but instead pass from cell to cell, irrespective of the nature of the tissues, either by way of the bordered pits or else by direct penetration of the cell walls. The hyphae are 2–5.5 μ in diameter, brownish in color, becoming sharply constricted where they pass through the cell walls, and give rise laterally to delicate hyaline or slightly colored branches (pl. 14, fig. 8) 1.8 μ in diameter, that grow closely applied to the inner surface of the cell wall. These delicate branches grow closely applied to the inner surfaces of the cell walls and penetrate the pits at frequent intervals.

To determine approximately what food substances this fungus requires it was grown on the media already used for the two species of *Helicoma*. The results, embodied in table III, show that

TABLE III

Medium	Av. growth in mm., after		Rate of growth per day	Relative per cent of perithecial bodies
	14 days	20 days		
Maltose	2.1	3.1	.16	00
Wheat starch	2.0	2.8	.13	100
Pectin	3.6	5.3	.27	50
Xylose	.45	.58	.02	00
Cellulose	1.9	2.6	.12	30
Asparagin	.37	.44	.01	00

pectin was the most favorable carbohydrate for vegetative growth, followed in the order named, by maltose, wheat starch, and cellulose. Spore production, however, took place only on pectin and maltose. The production of the perithecia-like bodies, mentioned in the consideration of the life histories, was greatest on the wheat-

starch medium, less on pectin and cellulose. On the remaining media no such bodies were produced. From this evidence and from the penetration of the hyphae into the bordered pits, it seems safe to conclude that pectin or pectin-like material plays an important rôle in the vegetative growth and spore production of this fungus.

A comparison of the development of the conidiophores and spores on artificial media with that on the natural-wood substratum shows that only on oatmeal agar do growth and reproduction take place as on the natural wood. On none of the other agars is spore production or the color or nature of the mycelium the same as in nature. For example, the conidiophores on potato-dextrose agar, instead of being stiff, erect, and seta-like, tend to grow very rapidly and to become a tangled mass of semi-repent or arched hyphae, for the most part bearing the spores in the typical fashion on bladder-like lateral projections (pl. 14, figs. 1, 5), but also producing some on the apex of the hyaline branches. Because of the fact that the spores under such conditions are produced terminally on branches, there may arise some doubt as to the value of the bladder-like projections as taxonomic characters. However, it is rather of interest as throwing light on the probable origin of these projections,—namely, from the suppression and specialization of the branches for the purpose of bearing spores. This hypothesis is further supported by the fact that after the first spores are produced, the projections lengthen, bear more spores, and occasionally, even on natural substrata, continue growth, becoming rather deeply colored and acquiring the nature of branches. The color of the colonies on potato-dextrose agar, as on most of the synthetic media, is "Citrine Drab" and is scarcely altered by the presence of the feebly colored spores; in nature and when cultivated on rolled-oat agar, it varies from "Wax Yellow" to "Dull Citrine Drab," depending on the number of spores present. Under such conditions also, the conidiophores are seta-like and deep fuscous.

Helicosporium gracile (Morgan) Linder.—Although growing well on most media tried, only on rolled-oat agar did *Helicosporium gracile* produce mycelium and spores resembling those of the natural growth on moist decaying bark. As is shown in table IV,

TABLE IV

Medium	Av. growth in mm., after		Rate of growth per day	Relative per cent of sporulation
	9 days	12 days		
Maltose	3.0	4.5	.50	00
Wheat starch	2.5	3.8	.43	50
Pectin	4.6	5.6	.33	100
Xylose	3.3	4.1	.27	00
Cellulose	2.1	4.1	.66	20
Asparagin	2.3	2.6	.10	00

growth on the various carbohydrate media, if the size of the colony be regarded as a criterion, is greatest on pectin, as is the relative percentage of sporulation. The color of the colonies on maltose and xylose was "Russet," the former with a "tawny" peripheral zone, the latter with a yellowish one; on wheat starch they were "Cinnamon Brown" with little aerial growth; on pectin "Mummy Brown" but covered by a weft of grayish hyphae; and on cellulose they were "Buckthorn Brown" with aerial hyphae relatively sparse. Spore production occurred continually on pectin, wheat starch, and cellulose, as shown in the table above. On maltose, however, there was only a slight amount of sporulation, and that only for a short period.

Helicomyces scandens Morgan.—On the natural bark substratum, colonies of *Helicomyces scandens* appear to be confined to the inner layer, that is, to the tissues nearest the cambium layer. In these tissues, however, there appears to be no apparent selection of the elements, and the hyphae penetrate in all directions while obtaining available nourishment.

The nature of this nourishment, shown by the following experiment and summarized in table v, varies considerably from that

TABLE V

Medium	Av. growth in mm., after		Rate of growth per day	Relative per cent of sporulation
	12 days	20 days		
Maltose	3.0	6.0	.262	00
Wheat starch	2.4	6.3	.49	40
Pectin	1.8	5.8	.50	30
Xylose	1.6	5.6	.50	00
Cellulose	3.1	8.5	.66	100
Asparagin	.83	4.0	.39	00

required by the majority of the other members of the group studied in this portion of the paper, in that cellulose is by far the most important source of carbohydrate material. The production of spores, also, is greatest on cellulose agar, much less on wheat starch and pectin agars, and none at all on maltose, xylose, and asparagin agars. On all the media except asparagin agar, the mycelium at the surface of, or in, the substrata, was colored some shade of brown: on maltose and wheat starch "Sepia"; on pectin and xylose, "Isabella Color"; on cellulose, "Dark Olive Gray," but on asparagin it was very dilute "Olive Gray." It can thus be seen that the nature of the substratum, in this species at least, has a marked influence on the color of the vegetative growth.

This species grows well and produces conidia on most artificial media, but here again rolled-oat agar proved most favorable. In spite of the fact that spores were produced in abundance, the setae formed under natural conditions on the bark substratum were not produced, even though the cultures were grown under a variety of conditions. Only when grown on potato-dextrose agar in van Tieghem cells were the setae in evidence, and then only in a very rudimentary stage beyond which they did not develop (pl. 12, fig. 3). Morgan[1] says of these setae, "I have not been able to convince myself that the black pointed threads which they (the hyaline conidiophores) usually enclose are not the erect stem of some black mould." From observations of many cultures the writer at first entertained these same doubts, and in an attempt to solve the question grew this with other wood-inhabiting Fungi Imperfecti that produced erect fertile hyphae, but the conidiophores of *H. scandens* did not climb these in any case. Whatever doubt that remained was removed later as a result of the careful study of an abundance of freshly collected material. In this, it was quite evident that the setae were produced as the colonies aged, and generally where the conidiophores, usually repent, had become ascending and fasciculate. The setae may easily be traced downwards to the hyaline hyphae that bear them, and these, not infrequently, may be found to bear conidia.

[1] Morgan, A. P. North American Helicosporeae. Cinci. Soc. Nat. Hist. Jour. 15: 39–52. 1892.

Helicodendron triglitziensis (Jaap) Linder.—The earlier studies[1] on the relation of the media to the growth of this species showed that, when observed in van Tieghem cells, lactose, fructose, glucose, and saccharose had no apparent influence on the abundance of the mycelium. When, however, in the present cultural studies, a comparison is made of the colonies of the fungus on maltose, wheat starch, pectin, xylose, and cellulose, the greatest amount of growth, as measured radially, is found on pectin agar, maltose, wheat starch, xylose, and cellulose following in the order named.

TABLE VI

Medium	Av. growth in mm., after		Rate of growth per day	Relative per cent of sporulation
	9 days	12 days		
Maltose	16.8	28.3	3.81	00
Wheat starch	16.7	25.3	2.84	00
Pectin	19.6	29.6	3.31	00
Xylose	16.6	24.1	2.50	00
Asparagin	7.1	9.3	.72	00
Cellulose	13.8	18.8	1.61	00

If the rate of growth be compared, then maltose appears to be most favorable for growth, followed by pectin, the order of the other media remaining the same.

Helicodendron tubulosum (Reiss) Linder.—*Helicodendron tubulosum* was found growing with *Helicodendron triglitziensis* on well-decayed, very wet twigs of *Salix lucida*. While these two species superficially appear alike, they may readily be separated on morphological characters of the spores. In culture the differences between the two species are very marked. *H. triglitziensis* does not produce pigment or colored hyphae in the substratum, while *H. tubulosum* does; the mycelium of the former is superficial, appressed, and hyaline, of the latter, aerial, loose, cottony, and some shade of gray (pl. 30, fig. 4). On corn-meal decoction, corn-meal decoction agar, potato-dextrose agar, and on rolled-oat agar, *H. tubulosum* produces an abundance of aerial mycelium, and of hyphae which grow through the substratum, turning it brown or black. The aerial mycelium in the center of the colony is "Wood

[1] Linder, D. H. Observations on the life history of Helicodesmus. Am. Jour. Bot. 12: 259–269. 1925.

Brown," shading to "Puritan Gray" near the periphery, which is often dilute buff; the colony is generally indistinctly zonate.

When growth on the different carbohydrate materials and asparagin is compared it is found to be equally rapid, within limits, on all. However, as is shown by table VII, while radial growth is most rapid on pectin and cellulose, the aerial mycelium is produced

TABLE VII

Medium	Av. growth in mm., after		Rate of growth per day	Relative per cent of sporulation
	9 days	12 days		
Maltose	8.1	15.3	2.24	80
Wheat starch	8.8	17.3	2.81	70
Pectin	11.3	21.6	3.42	60
Xylose	8.5	18.0	3.16	10
Cellulose	7.5	19.6	4.03	100
Asparagin	4.6	4.6	.00	00

rather sparsely. Spore production took place at the end of ten days, in relatively small quantities, on pectin. When, however, the cultures were exposed to freezing temperatures for two weeks and then brought back into the laboratory and maintained at room temperature, spores were produced readily on maltose, starch, and pectin, but especially abundantly on cellulose, in the proportions indicated by the table above. In respect to the color and nature of the mycelium, the fungus behaves most nearly as it does in nature when grown on pectin and cellulose. As has just been stated, on pectin and cellulose the mycelium was sparse, but on maltose, wheat starch, and xylose, dense pulvinate masses were formed. In nature, therefore, in all probability it is the cellulose and pectin of the decaying wood that is the source of carbohydrates for this species.

Helicoon sessile Morgan.—This species grows on very wet, decayed wood of deciduous trees, most commonly on maple and elm fallen at the edge of a brook or swamp or in similar wet localities.

Inasmuch as growth of the fungus is restricted in nature to such conditions, it is of interest to compare it on such substrata as asparagin and the various carbohydrates, and under different degrees of humidity, this last factor to be considered in a later chapter. Reference to the accompanying table shows that maltose and

TABLE VIII

Medium	Av. growth in mm., after		Rate of growth per day	Relative per cent of sporulation
	9 days	12 days		
Maltose	8.0	14.0	2.00	00
Wheat starch	6.8	7.6	.27	00
Pectin	10.0	14.6	1.53	00
Xylose	6.1	14.0	2.63	00
Cellulose	6.3	11.6	1.76	100
Aparagin	6.2	6.2	00	00

xylose are the most favorable for growth, yet only on cellulose, a mediocre source of nutrition, are spores produced. Such conditions as are exhibited by the cellulose medium appear to favor sporulation, since when the plant is grown on plain agar plus .3 per cent dextrose or saccharose, or even on very moist plain agar without sugar, spores are produced in relative abundance, generally in the zones where the mycelium is most dense. On potato-dextrose agar, however, spores are not produced, but instead there is an abundance of mycelium, thus bearing out an assumption that a less readily available supply of food material is conducive to spore formation. The development on rolled-oat agar is apparently inconsistent, since the spores are produced in relative abundance, accompanied by a luxuriance of growth. When the rolled oats were tested, however, it was found that the carbohydrates present consisted mostly of starch on which, as may be seen in the above table, vegetative growth takes place to but a slight degree. On analysis, tests for reducing sugars by Trommer's method gave negative results, thus showing that rolled-oat agar is similar to cellulose agar or other media in which the carbohydrate supply is not readily available. On the rolled-oat and the potato-dextrose agar substrata, the color of the mycelium is at first pure white, but with age becomes a beautiful shell-pink. Before pure cultures were obtained, it was noticeable that the presence of certain bacteria and yeasts induced still deeper coloration.

DISCUSSION

Color variations in the spores, conidiophores, and other aerial parts of the plant have been used for the purpose of distinguishing varieties, species, and even genera. As this basis has been used in

this group also, it is of interest to learn how variable that character may be and what factors are concerned in its variability. Of the many factors that might be involved, the most important, in the light of present researches, is the nature of the carbohydrate present in the substratum. Should carbohydrates be lacking, or should they not be available, as, for example, when *Helicoma Curtisii* is grown on asparagin or cellulose agars, the aerial mycelium, usually dark, is almost hyaline. With *Helicoon sessile*, the presence of certain bacteria or yeasts also may stimulate the production of color. Different degrees of hydrogen-ion concentration and of temperature, as will be observed later, may also cause color variations, but these factors are only of secondary importance as compared to the effects of the presence or absence of the different carbohydrates. Spore color appears within limits to be fairly constant, but may vary as to intensity. Formation by the mycelium of pigment and the diffusion of it into the substratum are also dependent on the nature of the medium. *Helicoma Mülleri* and *H. Curtisii* produce a soluble pigment on potato-dextrose agar, for example, while on Pfeffer's solution agar no pigment is produced.

As a result of these culture experiments with Schmitz's solution agar to which have been added the various carbohydrates and asparagin, it is difficult in all but one or two instances to see any correlation between vegetative growth and spore production. In certain cases, maximum sporulation accompanies maximum growth, as is exemplified by *Helicomyces scandens* and *Helicodendron tubulosum* when grown on cellulose agar, but here the correlation ceases, for second-best growth and second-best spore production apparently do not coincide. Each species has its peculiar requirement.

By a study of the accompanying chart (fig. 1) it will be seen for the majority of these saprophytic wood-inhabiting species, pectin, xylose, and cellulose, sugars similar to maltose, and even starch, make valuable sources of nutriment,—substances that are present in the natural substratum. Only *Helicoma Curtisii* shows no appreciable ability to utilize cellulose. Other carbohydrates are utilized in varying amounts, depending on the species. The utilization of these materials probably has little effect on the substratum unless the presence of certain sugars may allow a more

luxuriant growth and thus aid in the penetration of the wood by the fungi. Such a statement has been made by Rhoads[1] who says that xylose appeared to support the growth of *Collybia velutipes* and *Pleurotus ostreatus*, wound parasites of *Lupinus arboreus*. The species here considered, however, have never been found to be parasitic or wood-destroying in the economic sense of the word. Their rôle, judging by their slow growth and the nature of the carbohydrates utilized in culture, apparently is only to hasten the decay of wood and bark that has already begun to decompose. However, as Hubert[2] has already pointed out in the case of *Lasiosphaeria pezizula*, the ascigerous stage of *Helicoma Curtisii*, it is possible that some species may cause a certain amount of damage by their ability to discolor wood, or even to cause loss of strength in or near the parts infested by the mycelium. That the discoloration of the wood is not entirely due to the presence of fungus mycelium, as pointed out by that author, may be judged from the fact that *Helicoma Curtisii* produced on xylose agar a conspicuous "Mars Brown" discoloration. At all events, if ordinary precautions are taken in the storage of lumber, especially as regards ventilation, it seems that there is little likelihood of these fungi ever causing serious losses. Indeed, although this factor is dismissed by Schmitz[3] in the case of certain basidiomycetous wood-destroying fungi, it is quite probable that the typically saprophytic members of this group of helicosporous species may depend to a degree on the activity of cellulose bacteria.

SPORE PRODUCTION ON NATURAL SUBSTRATA

With the wide range of substrata on which some species grow, it is desirable from the taxonomic point of view to determine if any differences are created in the morphological characters of the spores, and to compare the material from the natural substrata with that from an artificial one. For this purpose, since they have larger spores and are more easily measured, *Helicoma*

[1] Rhoads, A. S. The pathology of Lupinus arboreus with especial reference to the decays caused by two wound parasites—Collybia velutipes and Pleurotus ostreatus. Phytopath. **11**: 389–404. 1921.

[2] Hubert, E. E. Notes on sap-stain fungi. Phytopath. **11**: 214–244. 1921.

[3] Schmitz, H. Relation of bacteria to cellulose fermentation induced by fungi with especial reference to the decay of wood. Mo. Bot. Gard. Ann **6**: 93–136. 1919.

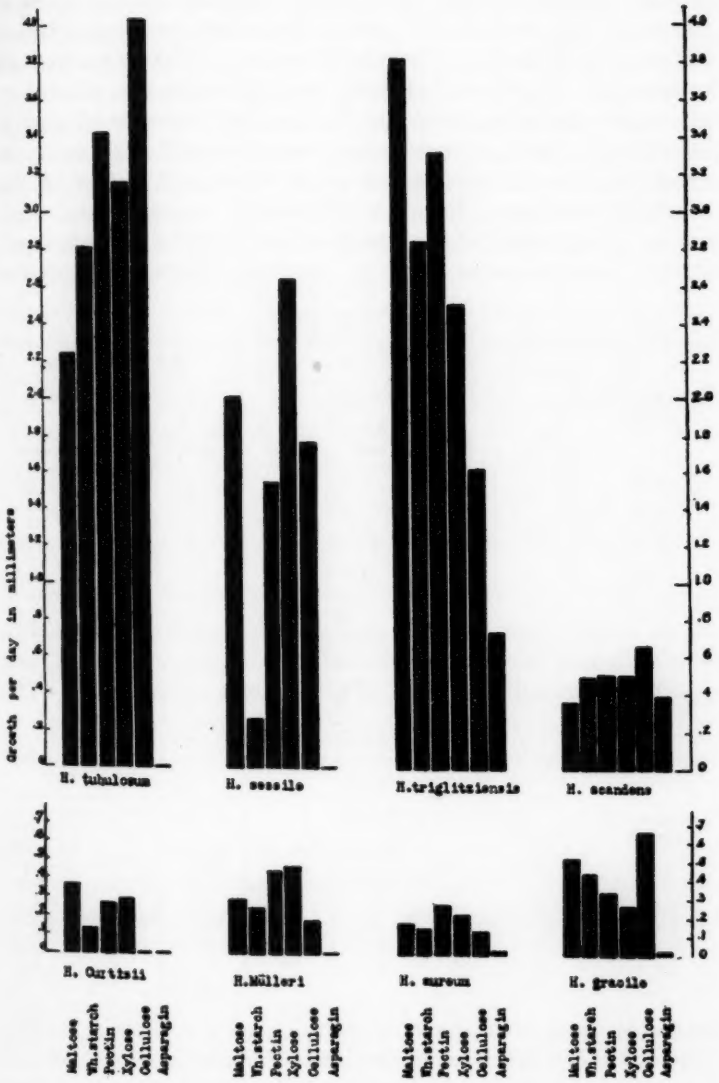

Fig. 1. Influence of substratum on rate of growth.

Mülleri and *H. Curtisii* were used. Accordingly, four sets of measurements were made for each of the two species growing on different hosts and on potato-dextrose agar. The spores were all mounted in 70 per cent alcohol; eosin-glycerine was allowed to run under the cover glass; and the preparations were allowed to stand for at least a week before measurements were made, in order that the material might come into equilibrium with the mounting medium. To avoid differences resulting from variations in the length of the uncoiled basal part of the conidium, the first measurements (table IX) were made across the diameter

TABLE IX

Measurement classes	*Helicoma Mülleri*				*Helicoma Curtisii*		
	Number of spores in				Number of spores in		
	Maple	Birch	Chestnut	Pot. D. agar	Swamp ash	Birch	Pot. D. agar
12.6 μ	1	—	—	8	2	—	3
14.4 μ	7	5	—	48	20	27	22
16.2 μ	16	15	8	45	20	23	22
18.0 μ	20	9	27	1	2	—	3
19.8 μ	—	—	12	—	—	—	—
21.6 μ	—	—	3	—	—	—	—

of the entire spore, at right angles to the point of attachment. The thickness of the spore filament, as shown in table X, was measured opposite the point of attachment of the spore. The

TABLE X

Measurement classes	*Helicoma Mülleri*				*Helicoma Curtisii*		
	Number of spores in				Number of spores in		
	Maple	Birch	Chestnut	Pot. D. agar	Swamp ash	Birch	Pot .D. agar
3.6 μ	3	8	12	—	—	1	6
4.5 μ	14	11	23	4	9	7	21
5.4 μ	23	8	15	25	34	34	22
6.3 μ	1	—	—	4	7	8	1
7.2 μ	—	—	—	1	—	—	—

results of these measurements show that for *Helicoma Mülleri* there is a slight difference in size between material from agar and from bark; that on maple, birch, and chestnut barks the greater number of spores are from 16.2 to 18.0 μ in diameter, on agar the

average number is greatest at 14.4 μ, and from that point they vary toward the smaller diameter. With *H. Curtisii*, the material from swamp ash and birch bark showed little variation from that on agar. In both species, the width of the conidial filaments varied but little, the greatest variation being shown by the spores of *Helicoma Curtisii* grown on the artificial substratum, but here the difference is only one micron and therefore is of little taxonomic interest. Similarly, when the number of coils, shown in table XI, and the number of septa, table XII, are compared,

TABLE XI

Number of coils	*Helicoma Mülleri*				*Helicoma Curtisii*		
	Number of spores in				Number of spores in		
	Maple	Birch	Chestnut	Pot. D. agar	Swamp ash	Birch	Pot. D. agar
1	1	—	—	—	—	—	—
1¼	4	—	—	4	2	—	2
1½	15	19	21	30	24	23	19
1¾	23	11	26	8	24	27	27
2	5	3	3	—	—	—	—

TABLE XII

Number of septa	*Helicoma Mülleri*				*Helicoma Curtisii*		
	Number of spores in				Number of spores in		
	Maple	Birch	Chestnut	Pot. D. agar	Swamp ash	Birch	Pot. D. agar
6	2	—	—	2	5	5	1
7	—	1	—	8	11	15	11
8	14	7	2	21	28	28	32
9	18	13	16	19	—	—	4
10	4	5	18	2	—	—	—
11	—	1	12	—	—	—	—
12	—	—	3	—	—	—	—
13	—	—	1	—	—	—	—

they are found to be quite constant in both species. It is evident, then, that these characters, supplemented by other peculiarities in the shape of the spores and spore filaments, are of decided value in the taxonomic treatment of this group of fungi.

HUMIDITY

The Helicosporeae require a relatively high degree of humidity, their habitat being the moist under-side of wood or bark, or even

on twigs partly buried in leaves. However, one of the species here considered, *Helicoma Curtisii*, appears to be capable of maintaining its existence in relatively dry situations. This species is not infrequently found growing under the dead bark of standing apple trees, in which situation it is subjected to a degree of desiccation during the summer months. Yet, while the species appears to be resistant to drought, for continued growth a high degree of humidity is a prerequisite, as will be seen later.

The seasonal occurrence also is correlated with the moisture requirements of these fungi. Although many may be found during the summer months in moist habitats, a number are found more frequently and in better condition as regards vegetative growth and spore production, in the spring and fall months.

The importance of humidity to the germination and growth of the organisms is clearly shown by the following experiments in which the moisture requirements were determined under controlled conditions by the method previously used by the writer:[1] In the bottom of van Tieghem cells was dropped a definite amount of sulphuric acid, the concentration of which varied according to the degree of relative humidity desired. The conidia were sown on potato-dextrose agar that had previously been placed on the under-side of a sterilized cover glass, which in turn was sealed to the cell by vaseline.

The spores of all species germinated readily at 100 per cent relative humidity. The percentage of germination and the length of time required for the process varied, as is to be expected, with the species. For example, 65 per cent of the spores of *Helicoma Mülleri* germinated in 24 hours and 96 per cent at the end of 48 hours; of the spores of *Helicosporium aureum*, 21 per cent germinated in 48 hours, and 88 per cent in 96 hours. The spores of the remaining species germinated in a similar fashion, the number producing germ tubes increasing with time until nearly all had germinated. Below 100 per cent relative humidity, there was a rapid falling off in the number of germinating spores. In fact, 98.8 per cent relative humidity appeared to be the lower limit, while at or below 95 per cent the conidia became plasmolyzed. The conidia of *Helicoma Mülleri*, *H. Curtisii*, and

[1] Linder, D. H. *l. c.*

Helicosporium gracile were the only ones that germinated at 98.8 per cent humidity. In this amount of moisture, 6.8 per cent of the spores of *Helicoma Mülleri* had produced germ tubes at the end of 48 hours; 4 per cent of those of *Helicoma Curtisii* had germinated in 96 hours; while in the case of *Helicosporium gracile* only a fraction of 1 per cent germinated in a month. In the last species, those spores that did germinate had changed considerably in appearance. The cells, as shown in pl. 14, fig. 11, had become deeply colored and greatly swollen between the septa, while only very short germ tubes were produced. The remainder of the species, with the exception of *Helicoon sessile*, remained turgid at 98.8 per cent relative humidity, although they did not germinate until again placed in an atmosphere of 100 per cent relative humidity. *Helicoon sessile*, however, proved to be extremely sensitive to changes in humidity, for at 98.8 per cent some of the cells of most of the spores were plasmolyzed; at lower degrees of humidity all were plasmolyzed.

In a previous paper it was stated by the writer[1] that "spores failed to germinate unless the humidity was above 49 per cent, while with the spores that germinated before the cell came into equilibrium, presumably because of the large amount of agar surrounding the spores, growth soon ceased . . . . ."

Since the more recent studies have demonstrated the fact that the other species of the Helicosporeae require a greater amount of moisture in which to germinate, the experiments with *Helicodesmus albus*, synonymous with *Helicodendron triglitziensis*, were repeated with smaller van Tieghem cells, less agar, and a greater amount of the sulphuric acid solutions in the bottom of the cells. The results show quite definitely that a higher degree of humidity than that previously stated is required for germination, the minimum being 98.8 per cent relative humidity.

The resistance of the conidia of different species to drying is extremely variable. The spores of *Helicoon sessile*, for example, when maintained at 97 per cent humidity for one week and then transferred to 100 per cent relative humidity, showed only 5 per cent of germination after 4 days, whereas 41 per cent of the spores of freshly collected material transferred directly to cells main-

[1] Linder, D. H. *l. c.*

tained at 100 per cent humidity germinated in 2 days. This species, however, is the most sensitive to the effects of drying. Spores of *Helicoma Mülleri*, on the other hand, when kept in a van Tieghem cell at 49 per cent relative humidity for two weeks and then transferred to 100 per cent relative humidity, germinated to the extent of 37 per cent at the end of 24 hours, and 66 per cent at the end of 48 hours. Thus, although there was lag in germination, the increase in the percentage in the spores exposed to conditions of severe drought for two weeks is approximately the same as that in spores from newly collected material transferred directly into cells maintained at 100 per cent relative humidity. It appears, therefore, that short exposures to drought has little effect on the viability of spores of certain species. When, however, spores were kept for nine months at the humidity and temperature of the laboratory, the results are quite different. Thus, spores of *Helicoma Mülleri*, *Helicosporium aureum*, and *H. gracile* did not germinate at the end of that period; those of *Helicoma Curtisii* and *Helicomyces scandens* did so even after eleven months, the former, however, only germinating to the extent of 4.8 per cent.

Vegetative growth is limited by the same conditions of humidity as is spore germination. This was shown by allowing spores to continue growth four days after germination in a saturated atmosphere, after which they were transferred to van Tieghem cells kept at relative humidities of 93–98.8 per cent. The growth of the mycelium was then measured at intervals.

Just as the conidia of the different species failed to germinate, so did the mycelium fail to continue growth below 98.8 per cent relative humidity. At this degree of humidity growth, when it did take place, was extremely slow. As an instance, the original germ tubes of *Helicoma Mülleri* made but little growth at 98.8 per cent relative humidity, even though measured at the end of thirty days. The original cells of the hyphae, as is shown by pl. 21, fig. 20, had become enlarged and rounded and new branches were produced. In these new branches the protoplasmic content appeared much denser and more highly refractive than that of the first-formed germ tubes, and the walls were less conspicuously bulging between the septa. This reaction to a dry environment, namely, the enlargement of the original cells and the production

of new branches with dense protoplasm, is characteristic of the majority of the species studied here. *Helicoma Curtisii* proved an exception, as vegetative growth was able to continue at a slightly lower degree of humidity than could spore germination. It was found that at 98.9 per cent relative humidity there was a definite growth of the original germ tube. At 97 per cent relative humidity growth of the original germ tube had been checked, but new hyphae, carrying on growth, were produced, while at 96 per cent relative humidity the original germ tubes had for the most part plasmolyzed and the new hyphae that had been produced grew at the expense of the original and then but very slowly. Although they were not measured, the hyphae of the crowded spores made better growth than did those that were isolated. Below 96 per cent relative humidity the germ tubes were plasmolyzed and no new hyphae were found. These results confirm the observations made from naturally growing material and indicate that, although the fungus requires very moist conditions for germination, once it has become established it may grow under a wide range of conditions.

From the preceding, it is evident that humidity is one of the very important factors in determining the growth and distribution of members of this group. Indeed, none of the species proved capable of continuing growth below 95 per cent relative humidity. Yet, in spite of the fact that on potato-dextrose agar in van Tieghem cells such very moist conditions are required, it does not appear to the writer that the limits of vegetative growth as thus shown are so fixed under natural conditions. Such factors as porosity of the substratum and abundance of capillary water must be considered. With these two factors favorable, as they are likely to be on the natural substratum, it would appear that moisture would be more readily available, even at lower degrees of atmospheric humidity than it is in van Tieghem cell cultures. Furthermore, it should be pointed out that in these cell cultures any moisture that might result from the metabolism of the organism is immediately absorbed by the sulphuric acid in the bottom of the cells. Therefore, these experiments, while indicating growth limits in a highly artificial environment, should

not be considered absolute, but rather as indicating general high-humidity requirements.

Similar allowances should also be made when the relation of humidity to germination of the spores is considered. Since the spores resting on the surface of the substratum are in less intimate contact with it, the experimental figures may prove a little higher than they actually are in nature. Nevertheless, they do indicate that a high degree of humidity is essential to germination. Similar experiments made by Zeller[1] with wood-destroying members of the Basidiomycetes also make this point clear, since, although in his trials he obtained a relatively small percentage of germination at as low as 63 per cent humidity, still the higher percentages of germinations were found to be correlated with the point of saturation of the wood fibres.

TEMPERATURE

In their natural environment these fungi, occurring as they do in moist shaded habitats, are for the most part protected from high temperatures. Furthermore, certain species, such as *Helicoma Mülleri*, *H. Curtisii*, and *Helicomyces scandens*, appear to be most abundant in the early spring, while *Helicodendron tubulosum* and *H. triglitziensis* occur in the late fall. The first two species are also found in the summer when conidia are produced abundantly, although but slightly more so than when found in March just after the snows had disappeared. *Helicomyces scandens*, however, appears during a more limited period, generally from the first of April until the middle of June in temperate regions. *Helicodendron tubulosum* and *H. triglitziensis* were found by the writer in relative abundance only in October and November, the same time of the year, apparently, that they occur in Europe. Such a seasonal appearance strongly suggested a correlation in certain species at least, between temperature and growth. To determine this point and also to discover other effects of temperature, the following experiments were performed.

In these experiments, the fungi were started on potato-dextrose agar at laboratory temperature. The radii of the colonies were

[1] Zeller, S. M. Humidity in relation to moisture imbibition by wood and to spore germination on wood. Mo. Bot. Gard. Ann. 7: 51–74. 1920.

measured at the end of 6 days, and the cultures were divided, one set placed in an ice-box that was maintained at 11° C., one in an incubator at 26° C., and another in an incubator that varied between 21 and 22° C. The figures derived from this work represent an average of three series at each temperature.

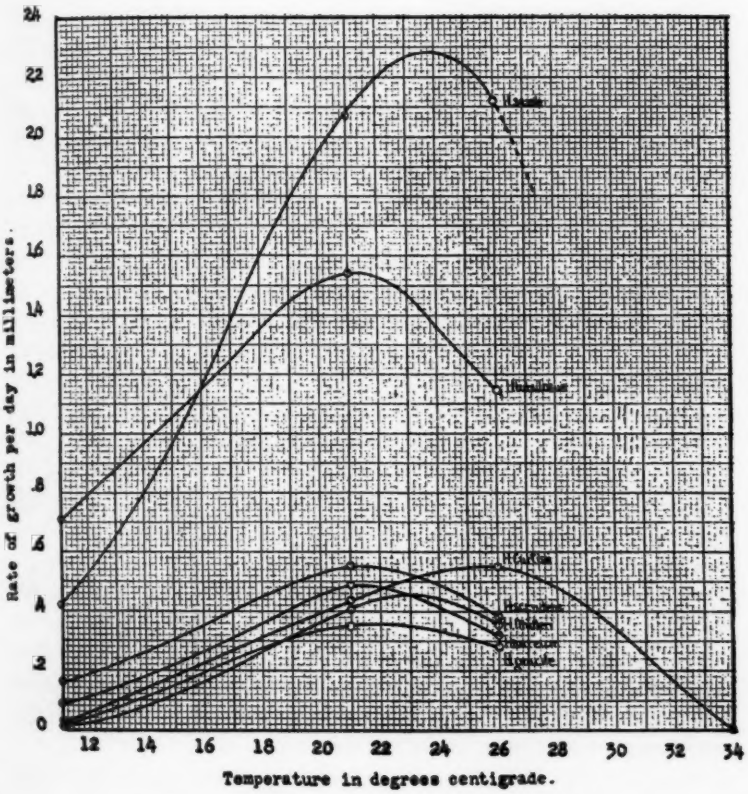

Fig. 2. Effect of temperature on rate of growth.

The results obtained show that the optimum range of temperature is between 21 and 26° C., as is shown graphically in the accompanying curves based only on three points of observation (four in the case of *H. Curtisii*) but constructed to correspond

with those of Fawcett.[1] These figures are slightly lower than those indicated for *Fusarium* spp., *Pythiacystis*, *Phytophthora*, *Diplodia*, *Phomopsis*, and most of the species of *Rhizopus*, since, as has been shown by the work of Tisdale,[2 3] Fawcett,[4] and Weimer and Harter,[5] the optimum temperature for growth of the species of those genera is between 24 and 30° C.

Production of conidia cannot always be correlated with maximum growth, although in the species studied here there is, in the majority of cases, such an agreement. *Helicoma Mülleri* produced spores equally abundantly at 11 and 21-22° C., although the rate of growth is .012 and .413 mm. (maximum) per day. *Helicodendron tubulosum* produced spores only at 11° C. and then not abundantly. When, however, cultures that were growing in the laboratory were exposed to freezing temperatures, −2.2 to −6.6° C., and then brought back into room temperature, spores were produced in abundance. *H. triglitziensis* behaved in a similar fashion, although it was previously stated[6] that "culture experiments indicate clearly that conidium production is dependent on exposure to sunlight . . ." When this species was again studied in the recent comparative work, sunlight apparently had little effect on sporulation unless the material had been exposed to freezing conditions and then returned to the temperature of the laboratory. It thus seems that cold has a marked effect and that the previous history of the cultures was not sufficiently considered, since the inoculum for the experiments on the effect of light came from test-tube cultures that had been left out of doors during the months of January, February, and March. Such a relation between sporulation and temperature would explain the occurrence of the fungi in October and November, at which time the organisms are subjected to low temperatures, or even frost, at night, and higher temperatures during the day.

[1] Fawcett, H. S. The temperature relations of growth in certain fungi. Univ. Cal. Publ. Agr. Sci. **4**: 183–232. 1921.

[2] Tisdale, W. B. Relation of temperature to the growth and infecting power of *Fusarium lini*. Phytopath. **7**: 356–360. 1917.

[3] ———, Influence of soil temperature and soil moisture upon the Fusarium disease in cabbage seedlings. Jour. Agr. Res. **24**: 55–95. 1923.

[4] Fawcett, H. S. *l. c.*

[5] Weimer, J. L., and L. L. Harter. Temperature relations of eleven species of *Rhizopus*. Jour. Agr. Res. **24**: 1–40. 1923.

[6] Linder, D. H. *l. c.*

The effect of freezing temperatures on the viability of the conidia is noteworthy, since asexual spores have been considered as a means of dispersion of species under favorable circumstances. As had already been pointed out in the case of *Helicodesmus albus* (*Helicodendron triglitziensis*), both conidia and mycelium are capable of surviving periods of cold without the aid of an asexual spore form. In the present experiments, cultures were exposed for three days to temperatures never higher than −2.2° C., and as low as −6.6° C. This exposure, though brief, did not impair the vitality of the spores. On the contrary, it increased the percentage of germination of the spores of *Helicoma Mülleri* from 96 to 98.5 per cent; of *H. Curtisii* from 28 to 94 per cent; and of *Helicoon sessile* from 41 to 92 per cent.

The color of the colonies of some species is also affected when grown at different temperatures. In fact, temperature appears to cause almost as conspicuous a change in color as does the presence or absence of a suitable carbohydrate material. *Helicosporium gracile*, when grown at 11° C., is "Dark Olive Buff" tinged "Olive Yellow" by the presence of the light yellow spores; at 21° the color of the colony is much the same except that it is lighter on account of more numerous spores; but at 26° the colony is "Light Brownish Olive." Colonies of *Helicosporium aureum* are "Smoke Gray" at 11° C., while at 21 and 26° C. they are "Citrine Drab" with a "Dark Olive Buff" periphery. *Helicoma Curtisii* and *Helicomyces scandens* also vary in color with differences in temperature, the former being "Water-Green" at 11° C., and "Lincoln Green" with an appressed almost colorless periphery at 21° C. or a buff-colored periphery at 26° C.; the latter species is "Deep Grayish Olive" with appressed mycelium at 11° C., lighter in color because of the more numerous conidia at 21° C. and almost black with a hyaline outer fringe at 26° C. The color of the colonies of the remaining species varied to some extent with changes in temperature, but not so conspicuously. Thus it is shown that temperature may be an additional factor in determining the color of the colonies of these species.

HYDROGEN-ION CONCENTRATION

In a comparative study of the growth of a group of fungi on artificial substrata, hydrogen-ion concentration is a factor that

must be taken into consideration, since it may cause changes in rate of growth and in the coloration of the colonies. These investigations therefore were undertaken primarily in order to dis-

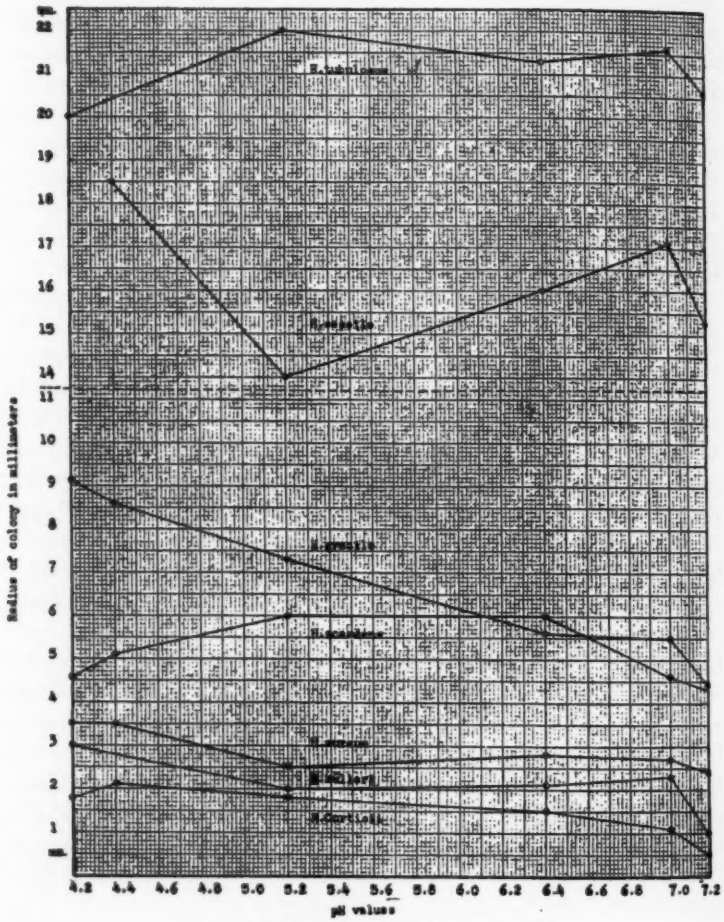

Fig. 3. Effect of hydrogen-ion on growth.

cover what influence, if any, changes in hydrogen-ion concentration of the substratum might have on the color of the fungi. In this respect the work proved somewhat disappointing, for, in

general, no differences were noted. *Helicoma Curtisii*, however, was an exception, since it reacted rather strongly in coloration to changes in acidity. Colonies started at pH 4.4 developed a fluffy mycelium which at the end of twenty days was "Light Yellowish Olive" at the center, shading to "Olive Yellow" at the periphery. In the colonies started at pH 5.2–7.2, the mycelium at the end of the same period was appressed and hyaline. To a lesser degree, *Helicosporium gracile* also showed changes in color, from "Sepia," the shade present from 4.2–7.0, to "Isabella Color" at 7.2.

By reference to the accompanying graph it will be observed that the points of maximum growth vary with the species, some of them occurring at the point of neutrality, others on the acid side of it, but none on the alkaline side. It seems probable that had it been possible to maintain the agar substrata at a more uniform hydrogen-ion concentration during the experiments there would be a sharper dropping off in the curves at or slightly on the acid side of neutrality. As it was, those cultures started at 7.0 and 7.2 tended to become acid, 6.6 and 6.8. In general, these results agree with those found by Wolpert[1] in the growth of various wood-destroying Basidiomycetes and indeed with the findings of other workers in the case of *Penicillium* among the Fungi Imperfecti, and the imperfect stage of *Sclerotinia*. On the contrary, vigorous plant pathogens, such as *Fusarium* spp., etc., according to the tabulations of Macinnes,[2] apparently find neutral or basic conditions more favorable for growth.

Summary

1. In these investigations, representatives of five of the seven genera of the Helicosporeae in the order Moniliales of the Fungi Imperfecti have been studied comparatively. Their life histories and their reactions under controlled conditions of environment have been noted.

2. The study of the life histories of these forms brings out the fact that in *Helicoma*, *Helicomyces*, and *Helicosporium* the spores

[1] Wolpert, F. S. Studies in the physiology of fungi. XVII. The growth of certain wood-destroying fungi in relation to the H-ion concentration of the media. Mo. Bot. Gard. Ann. **11**: 43–97. 1924.

[2] Macinnes, Jean. The growth of wheat scab organism in relation to hydrogen-ion concentration. Phytopath. **12**: 290–294. 1922.

possess hyaline or colored outer sheaths, and exospores which rupture as the spores swell in preparation for germination. So far as the writer is aware, this is the first time such structures have been reported in this group. It was also found that in the early stages, germination of the spores took place in two ways: 1, by the simple elongation of the terminal cells to form a hypha; 2, by the lateral production of germ tubes, chiefly from the central cells of the spore filaments. *Helicosporium gracile* germinates typically by the first method, and *Helicoma Curtisii* and *H. Mülleri* frequently do. The other species generally follow the second method of germination.

3. Heretofore, relations between the perithecial and conidial stages have been inferred from the presence of the two forms together. By pure, single-spore cultures, the perfect stage, *Lasiosphaeria pezizula*, was definitely shown to be connected with *Helicoma Curtisii*.

4. Polymorphism appears to be less frequent than was formerly supposed, and the life histories of the species more simple. Among the species studied in this part of the paper, only one, *Helicosporium aureum*, was found to produce more than one type of asexual spore, and that but very rarely.

5. When the fungi were grown on Schmitz's solution to which were added separately 4 per cent of maltose, wheat starch, pectin, xylose, cellulose, and asparagin, it was found that, considering both the amount of spores and vegetative hyphae produced, pectin and cellulose proved, in general, to be the most favorable sources of carbohydrate material. The other carbohydrates also played an important part in supplying nourishment for vegetative activity. Asparagin was utilized to but a small extent.

6. The fungi were found to be very dependent on the existence of a high degree of humidity for growth and germination. Not one of the species was able to germinate when conditions were under 98 per cent relative humidity, nor to continue vegetative growth under 96 per cent. Exposure to drying had different effects on the germination of the spores of different species. Spores of *Helicoon sessile* lost some of their vitality when exposed to an atmosphere kept at 97 per cent relative humidity. Other spores proved more resistant; those of *Helicoma Curtisii* and *Helicomyces*

scandens germinated after exposure of 11 months to the even drier conditions of the laboratory.

7. The optimum temperature for the growth of members of the group was found to be between 21 and 26° C., while sporulation was favored by cooler temperatures, especially in the case of *Helicosporium gracile*, *Helicodendron tubulosum*, and *H. triglitziensis*.

8. All species grew best in media that were acid or neutral. There was a rapid decrease in growth between Ph 7.0 and 7.2.

9. Factors influencing the color of the colonies on artificial substrata are type of carbohydrate present, temperature, H-ion concentration, and to a lesser extent the degree of relative humidity.

Part II. Taxonomic Treatment

This monographic study represents an attempt to bring order out of the chaos existing in the helicosporous Fungi Imperfecti. In studying those species already described an endeavor has been made to consult as many of the types as possible, and in this respect the writer has been extremely fortunate for only a few remain unstudied. Where types have been lacking, the original descriptions and illustrations have been sympathetically studied with the purpose of correlating those species with the material at hand. In spite of painstaking care there remain a few species whose identity is still doubtful.

In arranging the forms presented here, an attempt has been made to violate as little as possible the Saccardan system of classification while at the same time applying Morgan's system consistently. This latter system, based on the morphology of the spores, was decided on as a result of the study of the several species in culture and a greater number as they occur in nature. In the cultural experiments, as has already been pointed out, the color of the fungus, upon which the Saccardan system is based, varies with changes of environmental factors. In addition, it becomes clear from the study of a large number of species growing in their natural habitats that the age of the colonies also has a marked influence on the color. Thus we find that conidiophores of *Helicosporium lumbricoides* when young are hyaline but with age become deep fuscous. The color of the colonies changes ac-

cordingly from light gray to sepia. On the other hand, *Helicomyces scandens* both on the natural and the artificial substrata produces hyaline mycelium at first, but with age the creeping portions and the base of the short upright conidiophores become dilute fuscous or even a deeper shade, while the spores, at first white in mass, become pinkish and finally brownish. With the color so variable, it has seemed advisable to neglect the lines dividing the Dematiaceae and the Mucedinaceae and to combine the species in groups based on the morphological characters of the conidia. This step is not unprecedented, as will be evident from a perusal of works on the genus *Aspergillus*, in which fuscous spore forms are classified along with the non-fuscous ones without regard to the artificial lines created by the families Mucedinaceae and Dematiaceae. This practice has much in its favor, and the adoption of it generally would do away with much useless synonymy and the separation of obviously related forms.

The perfect stages of these fungi, as has been intimated earlier, are but rarely found and but few have been definitely connected with their imperfect spore forms. In the present work the writer has endeavored to collect all previous records of complete life histories and to test their veracity. It is thus hoped that more interest will be aroused in connecting the sexual and asexual stage and that out of this increased knowledge we may eventually obtain a better system of classification and a clearer idea of the phylogeny of the group. In the past, interest has been centered in only one or the other of the forms, and whereas one might have been adequately described, the other was generally neglected. On the basis of our present knowledge, it may be said, for the genera *Helicoma* and *Helicosporium* at least, that the conidial stage is correlated with the phragmosporous type of simple Sphaeriae, especially with the genera *Lasiosphaeria*, *Chaetosphaeria*, and *Acanthostigmella*. As for the problems of nomenclature that arise when the two phases in the life histories of these forms have been correlated, the writer has avoided changing the names of either for two reasons. In the first place, the names of such forms have become established in the literature and in general usage. To juggle them again increases the already-long list of synonyms without obtaining any advantages. Secondly, the

occurrence of the two stages together is so rare that it is necessary to have a separate system of classification for the perfect and imperfect forms. There appears to be little hope of avoiding such a bilateral system for some time to come. After all, it makes little difference whether we call the perfect stage of *Helicoma Curtisii*, *Lasiosphaeria Curtisii* or *L. pezizula* so long as we know the relations to be true, since *Lasiosphaeria* must still be classified among the Sphaeriaceae of the Ascomycetes and *Helicoma* in the Dematiaceae of the Fungi Imperfecti. In such cases it seems the technicalities of nomenclature should not be made a fetish.

The geographical distribution of the members of this group is indeed varied. Many species are to be found in North America and Europe, as is shown by a number of species among which *Helicoma Mülleri*, *Helicomyces roseus*, *Helicodendron tubulosum*, and *Helicomyces scandens* may be mentioned. The last named has also been collected in Chile. *Helicoma fasciculatum* and *H. simplex* appear to be confined to the Orient, although the former species has been reported from California. *Delortia palmicola* has been collected by the writer in tropical South America and in Africa. Cases of endemism, however, are not infrequent. *Xenosporella Thaxteri* and *Helicoma conicodentatum* have been collected respectively only in Trinidad and Grenada. The genus *Drepanoconis*, with two species, appears to be confined to South America, while the monotypic genus *Helicostilbe*, as emended in this paper, is confined to India. At present, our knowledge of the distribution of the members of this group is at best fragmentary, since too few collections have been made to allow the accurate mapping of their ranges.

In studying specimens, the writer has found it necessary to make microscopic preparations. The most satisfactory ones are made by sectioning the specimens as they occur on the substratum. When the species is an inhabitant of decaying wood, it has proved best to section the wood with the grain. Frequently, however, collections were so meager that it was more practical to employ a small, well-sharpened scalpel in order to remove, under a hand lens, a small portion of the specimen with a bit of the substratum. Material thus obtained was mounted in alcohol,

placed under a cover glass, and then eosin-glycerine was allowed to run into the specimen as the alcohol evaporated. A more satisfactory and more rapid medium was found in lacto-phenol as used by Sartory.[1] This not only swelled the material, but, if a small quantity of cotton blue were added, stained it at the same time. Permanent preparations were made by allowing such mounts to stand until the water in them had evaporated, a matter of a week or more, and then they were sealed by ringing with King's Amber Cement.

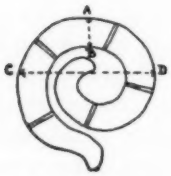

Fig. 4.

On all possible occasions a large number of measurements were made of each species in order to observe variations in size. In measuring conidia, it has been found necessary to adopt more or less fixed standards. The diameter of the coiled conidia was measured at right angles to the point of attachment, along the line c–d of the accompanying figure. The width of the conidial filament was measured opposite the point of attachment along the line a–b. On occasions when the spore was more than two- or three-times coiled, the outer and the middle coil were measured. Colors when given in quotation marks are those of Ridgway's 'Color Standards and Color Nomenclature,' Washington, 1912.

Citations have been kept as brief as possible and at the same time sufficiently ample for the identification of the material studied. The abbreviated names of the herbaria will be found in parentheses following the citations. The following is a list of abbreviations used:

B = Herbarium of the Botanical Museum, Berlin-Dahlem.
BM = Herbarium of the British Museum (Natural History), S. Kensington, England.
F = Farlow Herbarium, Harvard University, Cambridge, Massachusetts.
H = Herbarium of the University of Helsingfors, Helsingfors, Finland.
Ia = Herbarium of the University of Iowa, Iowa City, Ia.

[1] Sartory, A. Guide pratique des manipulations de mycologie parasitaire. p. 100. Paris, undated.

K = Kew Herbarium, Kew Greens, Surrey, England.
L = The writer's herbarium.
MBG = Herbarium of the Missouri Botanical Garden.
NY = Herbarium of the New York Botanical Garden, Bronx Park, New York.
NYS = Herbarium of the New York State Museum, Albany, N. Y.
P = Herbarium of the Museum of Natural History, Paris.
Pe = Herbarium of the Royal Botanic Garden, Peradeniya, Ceylon.
S = Herbarium of the Royal Botanical Museum, Stockholm, Sweden.

Key to Genera

1. Conidiophores forming a loose arachnoid, cottony or velvety colony, or else apparently obsolete, not forming a compact fruiting body (MUCEDINACEAE and DEMATIACEAE).....3
1. Conidiophores aggregated to form a compact structure.....2
2. Conidiophores aggregated to form a stele upon which the spores are borne acrogenously (STILBACEAE).....*Helicostilbe* (p. 333)
2. Conidiophores aggregated to form a flattened pulvinate or irregularly globose fruiting body (TUBERCULARIACEAE).....10
3. Conidia coiled in three planes to form a cylindrical or barrel-shaped spore body.4
3. Conidia coiled in two planes, or if in three planes then not as above.....5
4. Conidia in chains.....*Helicodendron* (p. 329)
4. Conidia not in chains.....*Helicoon* (p. 322)
5. Parasitic on vascular plants; conidiophores obsolete or as swellings of the vegetative hyphae; spores toruloid.....*Gyroceras*
5. Saprophytic or some doubtfully parasitic on other fungi; conidiophores present, in some not conspicuous but then spores are not toruloid.....6
6. Conidial filaments thick in proportion to their length, not hygroscopic....7
6. Conidial filaments thin in proportion to their length, hygroscopic.....9
7. Conidia in chains.....*Helicodendron* (p. 329)
7. Conidia not in chains.....8
8. Conidia longitudinally and transversely septate.....*Xenosporella* (p. 317)
8. Conidia transversely septate.....*Helicoma* (p. 295)
9. Conidiophores and conidia hyaline; the conidiophores as teeth on, or short erect branches from, the creeping vegetative mycelium.....*Helicomyces* (p. 270)
9. Conidiophores or conidia or both some shade of fuscous; conidiophores conspicuous.....*Helicosporium* (p. 275)
10. Sporodochia effuse-pulvinate, at first covered by epidermis of host, then erumpent; conidia once-coiled with thick hyaline walls..*Drepanoconis* (p. 341)
10. Sporodochia pulvinate to irregularly globose, dry, horny, or gelatinous; conidia without a conspicuously thickened wall.....11

11. Conidia coiled in three planes to form a conical or oblong-ellipsoidal spore body ..... *Troposporium* (p. 345)
11. Conidia not coiled in three planes, or if so then the filaments irregularly twisted and contorted 12
12. Conidia once-coiled, 1–3-septate; fructifications gelatinous... *Delortia* (p. 338)
12. Conidia not 1–3-septate, or if so then sporodochia not gelatinous 13
13. Conidial filaments 7 μ or more in width; conidia coiled in three planes, twisted and contorted ..... *Hobsonia* (p. 339)
13. Conidial filaments less than 7 μ in width; conidia not coiled in three planes.... 14
14. Conidiophores slender, even; fructifications horny when dry.. *Everhartia* (p. 335)
14. Conidiophores moniliform; fructifications not as above.. *Troposporella* (p. 334)

HELICOMYCES

Helicomyces Link, Ges. Naturforsch. Freunde Berlin, Mag. **3**: 21. *pl. 1, fig. 35.* 1809; Wallroth, Fl. Cryptogam. Germaniae **2**: 147–148. 1833; Saccardo, Syll. Fung. **4**: 233. 1886 (in part); Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 39. 1892 (in part); Lindau, in Engl. & Prantl, Nat. Pflanzenfam. **1** (1**): 451. 1900; Lindau, in Rabenhorst, Kryptog. Fl. Deutschl., Öst. u.d. Schweiz 1^8: 533. 1906.

Type species of the genus is *Helicomyces roseus* Link.

Conidia hyaline, white to pinkish in mass, the filaments slender, hygroscopic, convolutely coiled to form a disc-shaped body. The conidiophores present as teeth on the repent mycelium or as short erect, hyaline branches. Colonies effuse.

This genus as defined by Saccardo has in the past been a meeting place for all species in which the spores and conidiophores are hyaline, and thus came to include species with non-hygroscopic, relatively thick conidial filaments which have been transferred to *Helicoma;* species with the filaments coiled in three planes to form an ovoid spore body which have been placed in *Helicoon;* while those species with hygroscopic spores, but also with fuscous or dilute fuscous conidiophores, have found a position in the genus *Helicosporium.* The separation of the genera *Helicomyces* and *Helicosporium* is based on the fact that the conidia and conidiophores of the former are hyaline and that the mycelium is repent, not erect or ascending as in the latter. Such species with erect or ascending subhyaline or dilute fuscous conidiophores should be sought for in the genus *Helicosporium.*

KEY TO THE SPECIES OF HELICOMYCES

Colonies effuse, white or grayish to pink, but without bristle-like setae.
Conidial filaments 1.5–5 μ thick, coiled in two planes to form a flat disc.
Sterile mycelium and conidiophores mostly hyaline.
Conidial filaments 2.5–5 μ thick, the basal cell slightly swollen and attached obliquely to the sporogenous teeth.....*1. H. roseus*
Conidial filaments 1.5–2.5 μ thick, the basal cell slightly swollen.
.....*2. H. tenuis*
Sterile mycelium and conidiophores fuscous or dilute-fuscous....*3. H. bellus*
Conidial filaments 5–7 μ thick, the basal cell truncate, not swollen, coiled in three planes to a flattened helix.....*4. H. ambiguus*
Colonies effuse, whitish to pink; bristle-like setae present.....*5. H. scandens*

1. **Helicomyces roseus** Link, Ges. Naturforsch. Freunde Berlin, Mag. **3**: 21. *pl. 1, fig. 35.* 1809.

Helicomyces albus Preuss, Linnaea **25**: 725. 1852.

Helicomyces elegans Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 45. *fig. 8.* 1892.

Helicomyces clarus Morgan, *Ibid.* 44. *fig. 7.* 1892.

Plate 12, figs. 5–7.

Colony effused, forming a thin flocculose white to pinkish layer. Sterile mycelium creeping, hyaline or occasionally dilute fuscous below. Conidia hyaline, white to pinkish in mass, on teeth on the repent mycelium or on short erect branches, conidial filament slender, 2.5–4.5 μ, seldom 5.5 μ, in diameter, multiseptate, tapering to a terminal cell swollen at the base, which is generally abruptly rounded and obliquely flattened, irregularly coiled when moist, 2¼–3-times coiled when dry, and then the diameter of the coil is 30–45 μ in diameter.

Growing on seed-pods, decaying wood and bark. Widespread.

The diameters of the spore filaments of this species are extremely variable, from (2)–3.5 to 5.5 μ, but these extremes are the exception rather than the rule, since the majority of conidial filaments are 3–4.5 μ in diameter. Morgan, in his description of *Helicomyces elegans*, states that the spore filaments are 5–6 μ thick but the thickest filaments found by the writer on subsequent examination of material communicated by Morgan to Dr. Roland Thaxter is 4.5 μ. There is a possibility that two species may be combined here, but spore sizes intergrade so that it is impossible

to separate them without additional characters, which, however, appear to be lacking.

Specimens examined:

Exsiccati: Mycotheca Fairmani; Roumeguere, Fungi Gall. Exsicc., 2773; Saccardo, Mycotheca Veneta, 1245; Fuckel, Fungi Rhenani, 80.

England: Bristol, *H. O. Stephens* (K); Forden, *Vize* (K); West Kilbride, on rotten bark of *Fraxinus excelsior*, Oct. 1877, *D. A. Boyd* (BM); Stapleton Grove, Aug. 1845, *C. E. Broome* (BM).

France: *Boudier* (P); Ambert, Puy-de-Dome, July 7, 1900, *L. Breviere*, as *Helicosporium vegetum* (S).

Belgium: Graenendael, Nov. 1883, *C. Bommer & M. Rousseau* (P).

Germany: Eberswater, Oct. 1903, *Lindau* (B).

Austria: Rehgrabenberg, July, 1904, *v. Höhnel, 1118*, as *Helicomyces candidus* (F); Hostrichian, *v. Höhnel* (F); Purkersdorf, July, 1903, *v. Höhnel* (F); Kraustein, *v. Höhnel* (F).

United States:

New York: Lyndonville, *C. E. Fairman* (F).

Ohio: Preston, *Morgan*, as *H. elegans* (F).

Trinidad: *Thaxter* (F).

2. Helicomyces tenuis Spegazzini, Mus. Nac. Buenos Aires, Anal. **20**: 423. 1910.

Colonies arachnoid or *effuse*, suborbicular, 5–15 mm. *or more* in diameter; hyphae densely and intricately branched, 4–5 μ in diameter, septate, lax, and minutely papillate, hyaline; conidia filiform, 80–120 x 1.5–2 μ, circinate, terminal cells acute, slightly enlarged and obtuse at the basal cells, densely and minutely guttulate (*obscurely septate*), hyaline.

On putrescent culms of *Arundo Donax*. Lezama near Buenos Aires, Argentine, Nov. 1904. *C. Spegazzini*.

The above description, with the writer's modifications in italics, is translated from the original. This species appears to differ from *H. roseus* only in the smaller diameter of the conidial filament. Whether a colony is arachnoid or pulverulent appears to depend on the amount of spores present and in the length of the conidiophores, characters which vary with environmental conditions. The type has not been seen by the writer.

Specimen examined:
Surinam: Paramaribo, Nov. 7, 1923, *Linder, 346* (F).

3. Helicomyces bellus Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 42. *fig. 4.* 1892.

"Effused, forming a thin, flocculose stratum, gray with a pinkish tinge. Hyphae creeping, septate, branched, brownish-hyaline, bearing the spores on minute lateral teeth. Spores linear, hyaline, guttulate, faintly multiseptate, coiled quite regularly 2½–3½ times; the thread 140–180 mic. in length by 2.5–3 mic. in thickness; the inner extremity acute, the outer obtuse.

Fig. 5. *H. bellus.* After Morgan.

"Growing on old wood of Liriodendron, Juglans, etc. The hyphae creep close to the substratum and are nearly concealed by the abundant spores; they are nearly twice as thick as the thread of the spore."

4. Helicomyces ambiguus (Morgan) Linder, n. comb.
Helicoma ambiguum Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 49. *fig. 15.* 1892.

Plate 12, figs. 8–9.

Colony effuse, forming a thin flocculose, rose-colored layer ("Cartridge Buff" in dried material). Sterile mycelium hyaline, creeping, septate, and branched. Conidiophores hyaline, erect or bent, simple, septate, 10–30 x 2.5–3.5 μ. Conidia hyaline, acrogenous, multiseptate, the filament 3–5-times coiled in 3 planes, 5–7 μ thick, tapering toward the rounded distal end and

towards the truncate basal end; diameter of the coiled conidium 30–40 μ.

On decaying wood of *Platanus*. Ohio.

This species is quite distinct from *H. roseus* in that the thickness of the conidial filament is greater, the conidia are more pronouncedly coiled in three planes and are attached directly to the conidiophore and not swollen at the base and attached obliquely as in *H. roseus*. The conidiophores, also, are more pronounced in this species, the spores being confined to them and not produced on teeth or extremely short upright branches of the creeping mycelium.

Specimen examined:

United States:

Ohio: Preston, Aug. 2, 188?, *Morgan*, in herb. as *Helicoma apiarium*, TYPE (Ia, slide F, MBG).

5. Helicomyces scandens Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 42. *fig. 5*. 1892.

Helicostilbe helicina von Höhnel, Kön. Akad. Wiss. Wien, math.-nat. Kl. Sitzungsber. **111**: 1028–1029. 1902.

Plate 12, figs. 1–4; plate 30, fig. 2; plate 31, fig. 3.

Effused, forming a white to pink, setulose colony. Hyphae creeping over the substratum, or climbing the erect bristle-like setae and forming clusters, hyaline, septate, branched. Conidia slender, filamentous, indistinctly multiseptate, 3–4-times coiled, the filament 1.5–3 μ in diameter; the terminal cells acute, the basal cells obtuse at extremities.

On decaying wood and bark. Widespread.

This species in the young condition resembles *H. roseus*. Not only are the colonies pink and effuse, but also devoid of bristles, or if the bristles are present they are so few and scattered as to pass unobserved. With increasing age, however, the characteristic bristles become more evident and the conidiophores tend to become fasciculate, until in the more advanced stages of development the bristles and conidiophores have become so fasciculate as to take on the stilbaceous appearance which caused von

Höhnel to establish the genus *Helicostilbe*. In view of the fact that all stages from the effuse to the stilbaceous may be present and also because frequently only young material is available for study, the recognition of this genus as originally established, would only lead to confusion. It has therefore been emended and *Helicostilbe helicina* has been reduced to synonymy.

Aside from the presence of the dark bristles in *Helicomyces scandens*, this species may be separated from *H. roseus* by the more slender conidial filament, the lack of the rounded, swollen basal cells and the direct attachment of the conidia to the sporogenous teeth.

Specimens examined:

Austria: Wienerwald, on wood of *Carpinus*, May 11, 1902, *v. Höhnel*, type of *Helicostilbe helicina* (F).

United States:

Massachusetts: Canton, *Linder, 1003* (L); Waverley, June 1, 1891, *R. Thaxter* (F).

Connecticut: New Haven, decaying wood in greenhouse, *R. Thaxter* (F).

Ohio: Preston, on wood of *Carya, Morgan*, TYPE (F and ? Ia).

Missouri: Gray Summit, *Linder* (L, MBG 62347, F).

Chile: Correl, December, *R. Thaxter* (F).

SPECIES IMPERFECTLY KNOWN

Helicomyces albus Preuss, Linnaea **25**: 725. 1852.

"Acervulis effusis, albis; sporis basi adnexis, spiraliter subintortus, albis, episporio nucleo subpartito.

"Habitat in cortice arborum frondosarum."

The above is the original description. There are few details of taxonomic value, although since it is stated that the colonies are effuse and the spores are white and attached at the base, it might be implied that this species is very close to *Helicomyces roseus*, if not synonymous.

HELICOSPORIUM

Helicosporium Nees, Syst. d. Pilze u. Schwämme, 63. 1817; Persoon, Myc. Eur. **1**: 19. 1822 (in part); Fries, E., Syst. Myc. **3**: 354. 1832; Saccardo, Michelia **2**: 29. 1880 (in part); Saccardo, Syll. Fung. **4**: 557. 1886 (in part); Lindau, in Engl. &

Prantl, Nat. Pflanzenfam. I (1**): 487. 1900 (in part); Lindau, in Rabenhorst, Kryptog. Fl. Deutschl., Öst. u. Schweiz, 2nd ed. 1: 270. 1908 (in part).

Type species of the genus is *Helicosporium vegetum* Nees.

Conidia hyaline, light-colored or fuscous, the filaments slender, hygroscopic, convolutely coiled to form a disc-shaped body. The conidiophores conspicuous, dilute fuscous to fuscous, simple to much branched. Colonies effuse or cottony.

This genus is separated from *Helicomyces* in a purely arbitrary manner on the basis of the presence of elongate and conspicuous conidiophores. Such a basis for delimiting the genus was adopted in order to avoid the necessity of changing a large number of names and at the same time to detract as little as possible from the value of Saccardo's 'Sylloge Fungorum.' Species formerly in the genus *Helicotrichum*, before that genus was emended and placed in the Sarcopodiae by Saccardo, will, for the most part, be found in *Helicosporium* as constituted in this paper. On the other hand, those species with proportionately thick, non-hygroscopic spores, whether hyaline or fuscous, are to be found in the genus *Helicoma* where they form a more or less homogeneous group.

KEY TO THE SPECIES OF HELICOSPORIUM

1. Conidia yellow or greenish-yellow in mass....2
1. Conidia in mass some other color....6
2. Conidiophores fuscous or deep fuscous, at first simple or erect....3
2. Conidiophores dilute fuscous to subhyaline....5
3. Conidia borne on hyaline, bladder-like lateral projections from the conidiophores....4
3. Conidia not borne as above, on minute cylindrical teeth or slender branches....*1. H. vegetum*
4. Conidiophores 390–650 μ long, 5.4–7.2 μ thick near base, branching above at maturity....*2. H. aureum*
4. Conidiophores up to 480 μ long, 3.6–4.5 μ thick near base, not branching above at maturity....*3. H. guianensis*
5. Conidiophores subhyaline to dilute fuscous, pellucid, arising from repent or climbing mycelium....*4. H. gracile*
6. Conidial filament less than 4.5 μ in diameter....7
6. Conidial filament more than 4.5 μ in diameter....13
7. Conidiophores much branched and anastomosing at frequent intervals....8
7. Conidiophores sparsely branched, or if branched then not anastomosing at frequent intervals....9
8. Colonies velvety, up to 400 μ thick, easily separable from the substratum as loose mats of conidiophores; conidial filaments .9–2 μ thick; coiled conidium 18–25 μ in diameter....*5. H. lumbricoides*

8. Colonies effuse, short-velvety, up to 200 μ thick, not separable from the substratum as above; conidial filaments 1.8–2.5 μ in diameter; coiled conidia 21–29 μ in diameter.....*6. H. lumbricopsis*
9. Coil of conidia less than 10 μ in diameter; filament 1–2-times coiled; conidiophores fuscous, at first simple, erect, becoming branched and decumbent and bearing conidia on bladder-like projections.....*7. H. decumbens*
9. Coil of conidia more than 10 μ in diameter; conidiophores subhyaline to dilute fuscous, elongate, slender.....10
10. Conidial filaments 1 μ in diameter, conidiophores not much branched below..11
10. Conidial filaments 1.5–2.5 μ in diameter; conidiophores much branched below.....12
11. Conidiophores clearly septate, mostly simple, not anastomosing above. .....*8. H. griseum*
11. Conidiophores indistinctly septate, elongate, slender, sparsely anastomosing above.....*9. H. pallidum*
12. Conidial filaments 2–2.5 μ thick.....*10. H. albidum*
12. Conidial filaments 1.5–2 μ thick.....*11. H. phragmites*
13. Conidial filaments 8–10 μ thick; conidia on stout, simple or branched teeth 3–4 × 4–10 μ.....*12. H. serpentinum*
13. Conidial filaments less than 8 μ thick.....14
14. Terminal cells of conidiophores smooth; conidial filament 4.5–6 μ thick .....*13. H. nematosporum*
14. Terminal cells of conidiophores rough; conidial filaments 6.3–8 μ thick .....*14. H. Elinorae*

1. Helicosporium vegetum Nees, Syst. d. Pilze u. Schwämme, 68. *pl. 5, fig. 66.* 1817.

? Helicotrichum pulvinatum Nees, Acad. Caes.-Leop. Nova Acta **9**: 246. *pl. 5.* 1818.

? Helicosporium pulvinatum var. *effusum* Berkeley, Eng. Fung. Fl. **5**: 335. 1836.

Helicosporium Fuckellii Fresenius, Beitr. z. Myk. **3**: 101. *pl. 13, fig. 55–58.* 1863.

Helicosporium olivaceum Peck, Rept. N. Y. State Mus. **27**: 102. 1877.

Helicomyces olivaceus (Peck) Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 40. *fig. 1.* 1892.

Helicomyces vegetus (Nees) Pound & Clements, Minn. Bot. Studies **9**: 659. 1896.

Plate 13, figs. 1–3.

Colony at first finely hirsute, later somewhat cottony, "Sulphin Yellow" to "Dark Citrine." Conidiophores slender, 30–360 × 3–5 μ, at first erect, rigid, tapering to an acute subhyaline

point, later becoming somewhat flexuous, occasionally anastomosing, and producing short lateral branches below, hyaline when young, elongate, subfuscous at maturity. Conidia hyaline, yellowish or yellowish-green in mass, hygroscopic, at first borne acro-pleurogenously on slender, hyaline branches, later produced only pleurogenously on the lower part of the conidiophores, the filament 1 μ in diameter, 2–4-times convolute, the coiled spore 10–15 μ in diameter.

On decaying wood of deciduous trees, mostly of *Quercus*.

When only a few isolated specimens of *Helicosporium vegetum* in varying degrees of maturity are studied, the species appears to be a complex of many. Thus, study of the type specimen of *H. Fuckelii* demonstrates clearly that the species was described from nearly mature individuals which had given rise to lateral sporogenous branches. In the same collection the simple erect conidiophores typical of the younger stages of *H. vegetum* are also found. *Helicosporium pulvinatum* is apparently based on the very mature, loosely and much-branched condition of this species.

Specimens examined:

Exsiccati: Fuckel, Fungi Rhenani, as *Helicoma Mülleri*.

England: Mochay Lawn, May, 1839 (K); King's Cliffs, *Berkeley* (K); Lynn, on *Fagus*, May, 1872, *C. B. Plowright* (B, S).

France: Villebertin, May 28, 1882.

Germany: Eberbach, *Fuckel*, in Fungi Rhenani, as *H. Mülleri*, the type of *H. Fuckelii;* Triglitz, on decaying oak twigs, Nov., 1907, *O. Jaap*, as *H. pulvinatum* (B); Beinitz, Leipzig, on birch bark, *G. Winter* (B).

Austria: Wienerwald, June 9, 1907, *von Höhnel* (F); Wolfersburg, on *Quercus*, May 28, 1902, *von Höhnel* (F); Aggsbach, May 26, 1902, *von Höhnel* (F); Schacherswal, Redsalpe, June 6, 1900, *von Höhnel*, as *H. pulvinatum* (F).

United States:

Maine: Kittery Point, on hickory nuts, 1921, and Nov., 1923, *Thaxter* (F).

Massachusetts: Canton, on oak twigs, *Linder, 1042* (L), chestnut bark, *Linder, 1014* (L); Cambridge, Fresh Pond, June 1, 1905, *R. Thaxter* (F); Stony Brook, May 30, 1892, *R. Thaxter* (F).

Connecticut: Franklin, May 18, 1899, *W. A. Setchell* (F).
Ohio: Canton, on *Quercus*, *A. P. Morgan* (F); Preston, *Morgan*, as *H. olivaceum*.
Missouri: Gray Summit, *Linder* (F, L, MBG 66538); Meramec Highlands, *Linder* (F, L, MBG 66514); Sulphur Springs, *Linder* (F, L, MBG 66480).
Iowa: Iowa City, on acorn, March 4, 1927, *G. W. Martin* (Ia).
British Guiana: Botanic Garden, Georgetown, *Linder, 234A* (F, MBG 66595).

2. **Helicosporium aureum** (Corda) Linder, n. comb.
Helicomyces aureus Corda, Icones Fung. **1**: 9. *pl. 2, fig. 142*. 1837.
Helicosporium pilosum Ell & Ev. Torr. Bot. Club Bull. **24**: 476. 1877.

Plate 14, figs. 1–8; plate 30, fig. 3.

Forming a "Wax Yellow" to "Dull Citrine" or "Olive Citrine," loose cottony layer that is separable from the substratum. The conidiophores simple, erect, stiff and bristle-like at first, later branching from near the apex almost at right angles to the main rhachis, deep fuscous below, lighter above, with subhyaline tips that are easily broken off, 390–650 μ × 5.4–7.2 μ below, tapering upwards to 2 μ. Conidia pleurogenous, on hyaline, bladder-like projections, 5.4 × 5.4–10 μ, produced laterally on the lower parts of the conidiophores, dilute yellow, "Wax Yellow" in mass, the filament indistinctly 12–20-times septate, 3-times coiled, 1–2 μ in diameter; diameter of the coiled conidium 16–19 μ.

This species, microscopically, is quite distinct from other members of this genus, the outstanding characters being the erect seta-like conidiophore which at maturity branches above almost at right angles to the main axis, and the bladder-like projections on the lower part of the conidiophore. No types of this species exist, so far as the writer is aware, although we have Corda's figures as a basis for determination. In these figures the helical spores are shown spirally arranged around the conidiophore which Corda thought to be the host for the parasitic spores. The conidia are shown with flaring bases which appear to be a portion of the

bladder-like projections. Since Corda was acquainted with *Helicosporium vegetum*, it seems improbable that there was confusion between these in his mind, nor is there evidence that *Helicosporium gracile* entered into his consideration. Hence there seems to be little doubt but that this species is the one he described.

Specimens examined:

Exsiccati: Ell. & Ev., Fungi Columb., 1361; N. Am. Fungi, 125, as *H. vegetum*.

United States:

Maine: Kittery Point, Sept. 26, 1892, with *Helicoon ellipticum*, *R. Thaxter* (F).

Massachusetts: Canton, *Linder, 253, 1036* (L); Sharon, Oct. 15, 1918, *Piguet*, as *Helicosporium vegetum* (F); Readville, Oct. 1896, *R. Thaxter* (F).

New Jersey: *J. B. Ellis, 1434*, as *H. olivaceum* var. *canum* Ellis, in herb. (NY).

Connecticut: Milford, May, 1891, *R. Thaxter* (F).

South Carolina: *Ravenel* (K).

Florida: Eustis, September, October, 1897, *R. Thaxter* (F).

Alabama: Montgomery, *Burke* (MBG 51247a).

Mississippi: Starkville, Apr. 3, 1899, *G. W. Herrick* (F).

Iowa: W. Okaboji, July, 1928, *G. W. Martin* (MBG 65285, and Ia).

Louisiana: March, 1896, *Langlois, 2453*, type of *Helicosporium pilosum* (F).

3. Helicosporium guianensis Linder, n. sp.

Plate 13, figs. 5–6.

Colonies effuse, short-cottony, "Oil Yellow." The conidiophores at first simple and erect, later becoming bent, not branching above, somewhat loosely branched below and occasionally anastomosing, up to 480 μ long, 3.6–4.5 μ in diameter below, slightly tapering upwards to a rounded point. Conidia borne pleurogenously, at first on minute hyaline teeth, later on bladder-like projections which may continue growth, enlarge and become somewhat sympodially branched and dilute fuscous, yellow in

mass, hygroscopic, 3–3½-times coiled when tightly wound, the coil then 21.6 μ in diameter, larger when uncoiled, the filament 1.4–1.6 μ in diameter.

On buried twigs. South America.

This species resembles *Helicosporium vegetum* but differs from that species by the sympodially branched, subhyaline spore-bearing projections which arise from the lower part of the mature conidiophores. However, it more closely resembles *H. aureum*, from which it differs by the more slender conidiophores, the fact that the conidiophores do not branch above, and by the characters of the bladder-like projections.

Specimen examined:

British Guiana: Georgetown, Oct. 4, 1923, *Linder*, TYPE (F).

4. **Helicosporium gracile** (Morgan) Linder, n. comb.

Helicomyces gracilis Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 40. *fig. 2.* 1892.

Plate 13, figs. 4, 7; plate 14, figs. 9–11.

Mycelium effuse, forming an arachnoid, "Oil Yellow" to "Yellowish Citrine" colony. Conidiophores creeping and giving rise to erect, simple or branched, dilute fuscous or dilute olivaceous branches up to 150 μ long, 2.5–5 μ thick. Conidia hyaline or yellow in mass, borne singly on minute, hyaline, cylindrical teeth on the creeping fertile mycelium or on the lower portions of the erect conidiophores, filiform, multi-guttulate or indistinctly multi-septate, the filament coiled 3–3¼ times, 70–90 μ in length (Morgan), 1–1.5 μ thick; diameter of the coil 10–15 μ.

On dead bark of Sassafras (Morgan) and on decaying twigs and acorns of *Quercus*.

In gross appearance this species resembles *Helicosporium aureum* and *H. vegetum*. Microscopically it is distinguished from both by the creeping habit and the pellucid dilute fuscous or dilute olivaceous color of the mycelium.

Specimens examined:

United States:

Massachusetts: Canton, *Linder* (L).

Ohio: Preston ?, *A. P. Morgan*, TYPE (Ia).

Iowa: Iowa City, on acorn, March 4, 1927, *G. W. Martin* (Ia).

5. Helicosporium lumbricoides Saccardo emend. Matruchot, Recherches sur le développement de quelques Mucédinées, pp. 5–37. *pl. 1–2.* 1892.

Helicosporium lumbricoides Saccardo, Michelia **1**: 86. 1874.

Helicosporium griseum Berk. & Curt. Grevillea **3**: 51. 1874.

Helicosporium cinereum Peck, N. Y. State Bot. Rept. **33**: 28. *pl. 2, figs. 4–6.* 1880.

Helicosporium leptosporum Saccardo, Syll. Fung. **4**: 559. 1886.

Helicomyces cinereus (Pk.) Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 41. *fig. 3.* 1892.

Plate 15, fig. 5; plate 31, fig. 7.

Colony effuse or in small patches, pinkish-gray, light gray, or brownish, cottony, easily separable from the substratum. Conidiophores upright or ascending, much-branched and frequently anastomosing to form a network, subhyaline to deep fuscous, 3.6–4.4–(6.3) μ in diameter, forming a loose layer of hyphae up to 400 μ thick. Conidia pleurogenous, borne singly on delicate hyaline teeth on the lower three-fourths of the conidiophores, hyaline or white to pinkish in mass, the filaments hygroscopic, 0.9–2 μ in diameter, 3–4-times coiled, indistinctly many-septate; diameter of coiled conidia 18–25 μ or larger when somewhat uncoiled.

Growing on bark and decaying wood, mostly of deciduous trees. Wide-spread.

This species is a rather abundant one in the temperate regions. It is somewhat variable in its micro- and macroscopical appearance. The colony is regularly cottony and separable from the substratum. In color it is generally light gray or olivaceous but occasionally is dilute pink because of the spores and also may vary with that of the conidiophores. Rapidly growing or young conidiophores are frequently subhyaline, even to the base, but these with age become deep fuscous. Just as the color varies with the condition of the fungus, so does the frequency of anastomosis of the branches, but the plant is always essentially the

same, so that splitting off of species or even varieties seems highly unprofitable.

The type specimen of *H. griseum* B. & C., in Kew Herbarium, and the co-type of *H. cinereum* Pk. agree in all respects. *Helicosporium leptosporum* of Saccardo was published to care for *H. griseum* B. & C., since that name was preëmpted by *Helicoma griseum* Bonorden which was transferred to the genus *Helicosporium* by Saccardo. The writer has been unable to study the type of *H. lumbricoides* of Saccardo, who in publishing the species stated that the spore filaments were 4 μ in diameter. None of the specimens under this name in European or American herbaria possess spores with filaments of such a diameter. It seems advisable, therefore, from lack of evidence to the contrary, to accept Matruchot's emendation.

Specimens examined:

Exsiccati: Ell. & Ev., N. Am. Fungi, 2nd series, 2598; Ell. & Ev., Fungi Columb., 90.

Germany: Dauerbachgrab, Purkersdorf, June 5, 1904, *von Höhnel* (F).

Belgium: *Bonnier, 1* (K).

United States:

Maine: Kittery Point, on oak bark, July 26, 1922, Aug. 12, 1922, *Thaxter* (F); on red-oak bark, July 30, 1921, *Thaxter* (F); Cutts Isl., on oak bark, Aug. 1, 1922, and Aug. 12, 1922, *Thaxter* (F).

Massachusetts: Waverley, on *Ulmus*, Oct. 1899, on *Platanus*, Oct. 1892, on wet boards, Oct. 4, 1892, *Thaxter* (F); Canton, on chestnut bark, *Linder, 1917*, on decaying wood of *Fraxinus*, *Linder, 1349*, (L); Sharon, on oak plank, *Piguet* (L); Cambridge, Fresh Pond, June, 1895, *Thaxter* (F).

Connecticut: New Haven, on wood, in greenhouse, *Thaxter* (F), on rattan in greenhouse, 1890, *Thaxter* (F).

New York: North Greenbush, June, *Peck*, type of *Helicosporium cinereum* (NY and probably NYS); Milford, May, 1891, *Thaxter* (F).

New Jersey: Newfield, on old corn stalks, May, 1893, *Ellis*, in Ell. & Ev., Fungi Columb. 90.

South Carolina: *Ravenel*, type of *Helicosporium griseum* B. & C., in herb. Berkeley, 2446 (BM).

Louisiana: *Langlois, 675* (NY).
Missouri: Gray Summit, *Linder* (MBG 66570).
Ohio: Preston, on bark of *Platanus, Morgan*, in Ell. & Ev., N. Am. Fungi.
Iowa: Iowa City, on old cup of acorn, *G. W. Martin* (Ia).

6. Helicosporium lumbricopsis Linder, n. sp.

Plate 16, fig. 6; plate 17, figs. 5–6.

Colonies effuse, "Dark Olive" or "Pallid Neutral Gray" from numerous spores, occasionally with a slight pink tinge. Conidiophores at first simple, erect, from fuscous, repent mycelium, later branching, bending, and anastomosing, under high power of the microscope "Dresden Brown" to "Buckthorn Brown," the terminal cells of the branches hyaline, 25–200 × 3.6–5.4 μ, tapering upwards, bearing conidia acrogenously or pleurogenously on short hyaline teeth. Conidia hyaline, hygroscopic, the filament 3–4-times coiled, 1.8–2.5 μ in diameter, 18–23-times indistinctly septate, diameter of the coiled spore 21–28 μ.

On decaying wood. Tropical or subtropical.

Microscopically this species in its mature condition somewhat resembles *Helicosporium lumbricoides*, but differs from that species in the thicker conidial filaments, the greater diameter of the coiled spores, and the more robust conidiophores. Macroscopically the two species are distinct in that *H. lumbricopsis* does not form a loose, cottony, pulvinate colony that is easily separable from the substratum.

Specimens examined:
United States:
Florida: Cocoanut Grove, January, 1898, *Thaxter*, TYPE (F).
Venezuela: *Blakeslee* (F).
British Guiana: Georgetown, on buried twigs, *Linder, 277* (L); Bartica, *Linder, 727* (F).

7. Helicosporium decumbens Linder, n. sp.

Plate 15, figs. 1–2.

Colony effuse, stiff-velvety, dark brown or "Sepia." Conidiophores at first erect, simple, later branched, decumbent, fuscous

below, dilute fuscous towards the apices, 75–200 × 4–5 μ. Conidia pleurogenous, at first on minute hyaline teeth, later on bladder-like projections which subsequently elongate to become short branches, hyaline, filaments 1–2-times coiled, .75–1.5 μ thick, coil 6–9 μ in diameter.

On *Carpinus*. Austria.

This species is a characteristic one distinguished from all others in the small size of the spore and the few coils; also by the characteristic type of branching and swellings of the conidiophores.

Specimen examined:

Austria: Steinbachgrabe, Wienerwald, *von Höhnel, 2664*, TYPE (F).

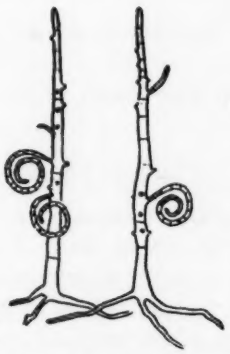

Fig. 6. *H. griseum*. After Bonorden.

8. **Helicosporium griseum** (Bon.) Saccardo, Syll. Fung. 4: 559. 1886.

Helicoma griseum Bonorden, Handbook, p. 74. *fig. 77*. 1851.

Plate 15, figs. 3–4.

Colony effuse, cottony, gray. Sterile mycelium dilute fuscous, septate, repent, often occasionally ascending and then tending to become fasciculate. Conidiophores erect or bent, simple or rarely branched, occasionally creeping and branched, dilute fuscous, becoming hyaline above, conspicuously septate, 108–250 × 3.6–4.5 μ, tapering above to slender apex 1–1.8 μ in diameter.

Conidia pleurogenous, borne singly on slender (1 μ) hyaline teeth, hyaline, the filaments 2½–4-times coiled, indistinctly many-septate, 1 μ in diameter; diameter of coiled spore 12.6–14.4 μ.

On decaying wood. Europe.

This appears to be very close to *Helicosporium albidum* and *Helicosporium phragmites*, but differs in the smaller diameter of the spore filaments and in being less frequently branched.

No spore measurements have been given, either by Bonorden or Saccardo, although Saccardo states that the conidia are 15–20-septate. The above description is drawn from a specimen in the von Höhnel collection which was classified as this species, and which agrees closely with the figure published in Bonorden's 'Handbook.'

Specimen examined:

Austria: Purkersdorf, Wienerwald, June 1, 1902, *von Höhnel* (F).

9. **Helicosporium pallidum** Cesati, in Rabenhorst, Bot. Zeit. **13**: 598. 1855.

Plate 16, fig. 1.

Colonies tufted, gray, becoming pinkish. Conidiophores sparsely branched below, simple above and occasionally anastomosing, dilute fuscous to subhyaline, hyaline above, slightly tapering upwards; septa inconspicuous, up to 580 μ long, 1.5–4 μ thick. Conidia borne pleurogenously on slender cylindrical teeth, hyaline, the filaments 1 μ in diameter, coiled 2–3½ times; diameter of coiled spore 10–15 μ.

On decaying wood. Europe.

There is a great similarity between this species and the preceding, the only difference being that in this one the septa of the conidiophores are rather inconspicuous and the conidiophores are more elongate and slender and anastomose above with neighboring ones. It is quite possible that the two species are identical and are based on differences which depend on the age of the organism.

Specimen examined:

Exsiccati: Rabenhorst, Herb. Myc., ed. 2, 62, TYPE.

Italy: Vercelli, in Rabenhorst, Herb. Myc.

10. Helicosporium albidum Grove, Jour. Bot. **24** (N. S. **15**): 204. *pl. 267, fig. 6.* 1886.

Hyphae erect, septate, hyaline, at first simple, then branched below, 2½–3 × 200–300 μ, branches long, ascending, sterile, and flagelliform; conidia pleurogenous, substipitate, hyaline, multiguttulate, 2–2½ μ diameter (of conidial filament), base attenuate, apex rounded, densely 4 times convolute, diameter of coiled spore 15–20 μ. Colonies white, velvety.

On slender branches of *Rubus fruticosus*, Middleton, April. *Grove.*

11. Helicosporium phragmites von Höhnel, Ann. Myc. **3**: 338. 1905.

Plate 16, figs. 2–5.

Colonies effuse, cottony, brownish-gray, tinged pink by spores. Conidiophores branched below, simple above, very dilute fuscous below, hyaline above, up to 350 μ long, 2.5–4.5 μ in diameter, slightly tapering upwards to bluntly rounded apices, bearing spores pleurogenously on slender hyaline teeth, 1 × 1–2.5 μ. Conidia hyaline, light pink in mass, the filament 3–4-times coiled, multiseptate, 1.5–2 μ in diameter, coiled spore 15–18 μ in diameter.

This species, except for the slightly smaller spores, appears to be identical with *Helicosporium albidum*, but since the writer has been unable to see a representative of the latter species and also since von Höhnel has described the perfect stage of the former, it seems advisable, for the present at least, to maintain the two as distinct. Von Höhnel, in his description, stated that the perfect and imperfect stages were in association. Study of the type material indicates clearly that the two stages are not only in association, but are actually connected. The description of the perfect stage follows:

Acanthostigmella genuflexa von Höhnel, Ann. Myc. **3**: 327–328. 1905.

Perithecia superficial, scattered, spherical or subovoid, 70–80 × 100 μ, the perithecial walls thin, brown, ornamented around the short cylindrical ostiole with dark brown, recurved, septate

bristles 60–80 × 4–5 μ, otherwise the perithecium is smooth. Paraphyses lacking; asci broadest in the middle, tapering towards either end, 30–35 × 8 μ; spores as many as 8, irregularly arranged, greenish-hyaline or dilute olive in mass, spindle-shaped, tapering towards the bluntly rounded ends, 1–2-times septate.

Specimens examined:

Austria: Tullu, on decaying stalks of *Phragmites communis*, June 3, 1905, *von Höhnel*, TYPE (F).

United States:

Maine: Kittery, on old *Carex* in bottom of dried-up pond, June, 1893, *Thaxter* (F).

12. Helicosporium serpentinum Linder, n. sp.

Plate 17, figs. 1–4.

Colony effuse, hirsute, "Saccardo's Olive" to "Saccardo's Umber." Conidiophores light brown, becoming subhyaline in terminal cells, at first simple, erect, from creeping hyphae, then bent and occasionally branched, rather closely septate, the length of the cells being 1½–3 times the width, 76–216 × 5.4–9 μ. Conidia produced acro-pleurogenously on hyaline, simple or branched sporogenous teeth, 2–4 μ in diameter, "Cream buff" to "Chamois" under the high power of the microscope, hygroscopic, the filament 15–30-septate, breaking readily at the thicker septa where the filament is slightly constricted, 8.5–11 μ thick in the middle, tapering to 5.4–4.6 μ at the rounded distal end, 4.5 μ at the truncate basal end; conidia when coiled 55–100 μ.

On decaying wood. Missouri.

This species is closest to *Helicosporium nematosporum* but differs from that species by the dimensions of the spores and conidiophores and the stouter and branched sporogenous teeth.

Specimen examined:

United States:

Missouri: Pacific, on decaying wood, Oct. 1927, *Linder*, TYPE (F, L, MBG 64721).

13. Helicosporium nematosporum Linder, n. nom.

Helicomyces fuscus Morgan, Cinci. Soc. Nat. Hist. Jour. 15: 48. *fig. 14.* 1892.

Plate 18, figs. 1–5.

Effuse, forming a thin "Dresden Brown" hirsute colony. Sterile mycelium repent, septate-branched, light brown, translucent, giving rise to distant or subdistant concolorous conidiophores. Conidiophores simple or sparsely branched and occasionally anastomosing, erect or ascending, septate, brownish, translucent, hyaline at the terminal cells, 90–250 × 5.4–8.0 μ, tapering slightly towards the abruptly rounded apex. Conidia pleurogenous, borne singly on conspicuous hyaline teeth (1.8 × 1.8–3.6 μ), hygroscopic, dilute fuscous, even, 28–60-septate, 2½–4-times coiled, the filament 4.5–6 μ thick, gradually tapering to 3 μ at both extremities, the distal extremity bluntly rounded, the basal bluntly rounded and flattened obliquely where it is attached to the sporogenous teeth; diameter of spore when tightly coiled 45–50 μ, when loosely coiled 85–100 μ.

Growing on decaying wood.

In addition to the helical spore, there is present in the Connecticut material the "sclerote pedicelée" of Matruchot, which is shown in pl. 18, fig. 2. In the British Guiana specimen, the perfect stage has been found in connection with the imperfect one. In the tropical material, although the conidiophores are simple and erect at first, they show a strong tendency to anastomose in the more mature stages of development.

Specimens examined:

United States:

Connecticut: New Haven, in greenhouse on rattan, *Thaxter* (F).

Ohio: Preston, on wood of *Juglans*, *Morgan*, TYPE (F).

British Guiana: Georgetown, on sheath of royal palm, *Linder*, *236* (F, L); Plantation Vryheid, Demerara River, on sheath of manicole palm, *Linder*, *881* (F, L).

The description of the perfect stage is as follows:

Lasiosphaeria nematospora Linder, n. sp.

Perithecia scattered, black, subspherical with ostiole as a low papilla, at first with scattered bristles or a few conidiophores, later almost smooth, 200–300 μ in diameter. Asci clavate. Ascospores distichous or tristichous, hyaline at least before completely mature and then dilute fuscous, 5–11-septate, 45–58 × 3.1–3.6 μ, tapering toward both extremities, somewhat spirally twisted.

On sheath of royal palm, Botanic Garden, Georgetown, British Guiana, *Linder*, *236*, TYPE (F).

14. Helicosporium Elinorae Linder, n. sp.

Plate 18, figs. 6–10.

Colony effuse, bristly, "Raw Umber." Conidiophore erect or curved, ascending from repent mycelium, dilute "Buckthorn Brown" under the high power of the microscope, to fuscous, the terminal cells lighter, granulate-roughened by crystal-like deposits, 180–260 × 7.2–10.5 μ. Conidia pleurogenous on stout (4 × 5–7 μ) hyaline teeth, dilute fuscous to fuscous, hygroscopic, filament coiled 3–5 times, often in 3 planes, multiseptate, 6.3–8 μ in diameter, slightly tapering to the rounded distal end and to truncate basal end.

On decaying wood. Surinam.

This species, in addition to differences in dimensions, differs from the preceding species by the granular roughening of the terminal cells of the conidiophores. The perfect stage of this species was also found connected with the above-described imperfect stage, and is described as follows:

Lasiosphaeria Elinorae Linder, n. sp.

Perithecia subovate, scattered, black with brownish hairs among which are often conidiophores, 480 × 520 μ; asci 8-spored, clavate, 144 × 12.6–16.2 μ; paraphyses slender, 1–1.5 μ, wavy, hyaline, exceeding the length of the asci; ascospores dilute fuscous, the basal cell often conspicuously narrowed, hyaline, the distal cell bluntly rounded, 5–5.5 × 54–63 μ.

The writer takes great pleasure in dedicating this species to his wife, whose interest has ever been a source of encouragement.

Specimen examined:

Surinam: Upper Cottica River, on decaying chips of wood, *Linder, 382*, TYPE (F, L).

SPECIES IMPERFECTLY KNOWN

Helicosporium albo-carneum (Cr.) Saccardo, Syll. Fung. 4: 559. 1886.

Helicotrichum albo-carneum Crouan, Florule Finistere, p. 12. 1867.

"Touffes de 2 à 3 millim., d'un blanc-carne, à filamente rampants emettent des filaments cloisonnés peu rameux supportant lateralment des sporanges heliciformes.

"Sur une tige mort de Ronce."

From the meager description above, it is apparent that this species should be placed in the genus *Helicomyces*, since the repent mycelium and the hyaline to pinkish spores definitely relate it to *Helicomyces roseus*.

Helicosporium brunneum Schulzer & Saccardo, Hedwigia **23**: 126. 1884.

Helicotrichum brunneum Schulzer, Flora **60**: 272. 1877.

"Effusum, tenue, brunneum, subvelutinum; hyphis primariis fasciculato-stipitiformibus subramosis (an propriis ?) hyphis fertilibus ex illis egredientibus, filiformibus non collabescentibus subsimplicibus, septulatis, melleo-fuligineis 2–6 micr. d.; conidiis pleurogenis filiformibus in spiras tres arcte convolutis, dense septatis, fuligineis, ubi convolutis diam. 20–22 micr.

"Hab. in fragmentis ligneis Salicis pr. Vinkovce."

The above description is that of Schulzer and Saccardo in Hedwigia. In the original description of *Helicotrichum brunneum* in Flora, Schulzer gives additional information. Thus the thickness of the colony is given as about 3 mm., formed of many thin united threads that with their branches make a loose tangled "hyphasma." In addition to the description of the hyphae, the spores are also described as hygroscopic. Thus there is little doubt that this species belongs to the genus *Helicosporium*. From the fact that the hyphae anastomose, there is a suggestion that the species should be considered as very close indeed to *H. lumbricoides*. As a matter of interest, Schulzer remarks that *H. brunneum* grew in association with *Lasiosphaeria botellospora* De Not.

Helicosporium Ellisii Cooke, Quekett Microsc. Soc. Jour. **4**: *pl. 26, fig. 24*. 1877; Sacc. Syll. Fung. **22**: 1436. 1913.

This species was only figured by Cooke and was not described until Saccardo, using Cooke's figure as a basis, gave the following description:

"Conidiophoris erectis, strictis, obsolete septatis, non constrictis, filiformibus, 500–600 × 4–5 μ, brunneis; conidiis (acrogenis) cylindricis, spiraliter convolutis, 4–5-septatis, non constrictis hyalinis, totis (convolutis) 22 μ latis, spicalis binisternis, 4–5 μ cr.

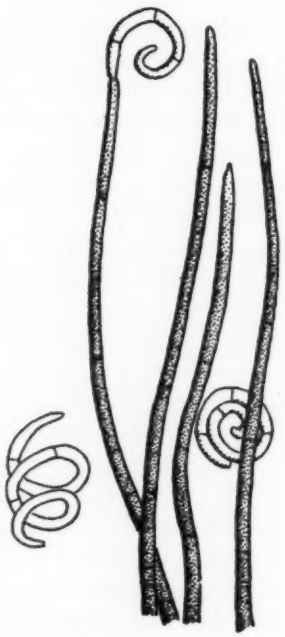

Fig. 7. *H. Ellisii*. After Cooke.

"Hab. ad truncos (?) in America boreali."

The validity of this species is very questionable since, figured on the same plate with it, is *H. vegetum*, the spores of which were shown as being produced acrogenously, not pleurogenously, as should be the case. Furthermore, the writer, in going over the collections in the British Museum and in the herbarium at Kew, was unable to find any material representing the species. Therefore, before accepting it as valid, it seems best to await the discovery of Cooke's type or at least material that is comparable.

Helicosporium herbarum Sacc., Bomm. & Rouss. in Bommer, E. & M. Rousseau, Soc. Roy. Bot. Belg. Bull. **29**: 299. 1891.

"Groupes petits, arrondis, floconneux, couchés, d'un gris cendré. Filaments rampants, hyalins puis fuligineux, longuement ramifiés, flexueux, septés, 4.5–5, émettant sur leur parcours, de trés courtes verrues hyalines sur lesquelles naissent des conidies nombreuses, 1.5–2, hyalines, filiformes, enroulées en une

spire serrée formant 4 tours, pluriseptées, ne se déroulant pas, mais se divisant. La conidie enroulée mesure 13–15 de diamêtre. —Sur une tige morte d'*Epilobium hirsutum*. Groenendael. Oct. 1887.

"Espèce voisine d'*Helicosporium albidum* Grove, dont elle diffère par les filaments brunâtres, toujours couchés, les conidies sessiles, septées à base non atténuée, etc."

The writer has been unable to obtain material of this species. There are, however, few characters that could be considered of weight in separating it from *Helicosporium albidum*, *H. griseum*, *H. pallidum*, and *H. phragmites*, unless it is the size of the spores. *H. albidum* has thicker conidial filaments (2–2.5 μ), while those of *H. griseum* and *H. pallidum* are thinner (1 μ). There thus remains the possibility that *H. phragmites* is identical with this and should be considered a synonym, but until material of *Helicosporium herbarum* is available for comparative study, such a treatment, in view of the uncertainty concerning this group of five species, would be decidedly premature.

Helicosporium populi (Cr.) Saccardo, Syll. Fung. **4**: 560. 1886.
Helicotrichum populi Crouan, Florule Finistere, p. 12. 1867.

"Touffes arrondies de 1 à 2 millim; grisâtres, formées par des filaments nombreux, cloisonées, rameux, dichotomés terminés à leurs sommets par des sporanges heliciformes.

"Sur la partie de l'ecorce d'un Peuplier mort."

Helicosporium prasinum Preuss, Linnaea **24**: 111. 1851.

"Thallo bombacino prasino; floccis intricatis, septatis; sporis flocciformibus, apice lateribusque in cylindro spiraliter tortuosis diaphanis dilute prasinis.

"Habitat in asseribus semiputridis."

Saccardo[1] suggests that this species may be synonymous with *H. pulvinatum*.

Helicosporium pulvinatum (Nees) Persoon, Myc. Eur. **1**: 19. 1822.
Helicotrichum pulvinatum Nees, Acad. Leop. Nova Acta **9**: 246. *pl. 5, fig. 15.* 1818.

"Caespitulis late effusis sordide albido-lutescentibus, demum

[1] Saccardo, P. A. Sylloge Fungorum **15**: 156. 1901.

obscurioribus; hyphis filiformibus, ramosis vel chlorino-fuligineis, 3–4 μ diam.; conidiis in spiras 2½–3 convolutis, 2 μ diam. continuis plurinucleatis, hyalinis, 70–80 μ long."

The above description and figure is taken from Saccardo's[1] account of the species. If one may judge by the specimens under this name in the various exsiccati and in the herbaria of Europe

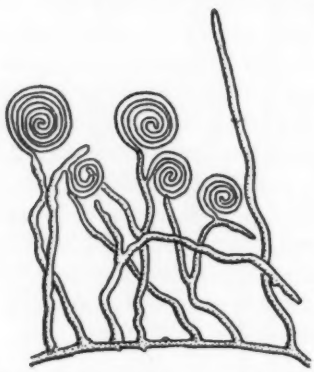

Fig. 8. *H. pulvinatum.* After Saccardo.

and America, this species should be considered as synonymous with *Helicosporium vegetum*, yet in view of the figure given by Saccardo, additional material must be studied before the status of the species can be determined. The writer has been unable to discover any specimens that correspond to the description given above.

EXCLUDED SPECIES

1. **Gyroceras nymphaearum** (Rand) Linder, n. comb.
   Helicosporium nymphaearum Rand, Jour. Agr. Res. 8: 219–232. *pl. 67–70.* 1917.

Mycelium intercellular, light brown, often hyaline in culture, septate and branched. Conidiophores slender, 2–3 μ in diameter, inflated at the apices, 6–7.5 μ, often becoming branched and thus producing several conidia in clusters. Conidia 60–170–(190) μ, brown, many-septate, strongly constricted at the septa, the apical cell subspherical or ovoid, flattened at the point of contact with

[1] Saccardo, P. A. Syll. Fung. 4: 557. 1886; Fungi Ital. *fig. 811.* 1881.

the penultimate cell; the basal cell rounded-tapering; the remaining cells generally longer than wide and minutely tuberculate.

Parasitic on leaves of *Nymphaea* sp. New York, New Jersey, and Washington, D. C.

This species differs from all known species of *Gyroceras* because of the minutely tuberculate sculpturings of the conidial walls, the deep constrictions at the septa, and the morphology of the conidiophores. Because of the absence of definite aerial conidiophores and on account of the structure of the spores, this species must be excluded from the genus *Helicosporium*.

Rand (*l.c.*) reports the presence of sclerotia that are rounded, subcarbonaceous, and measuring 150–190 μ in diameter. No perfect stage has as yet been associated with this species.

Specimen examined:

United States:

Washington, D. C.: *Rand*, TYPE (U. S. Dept. Agr. and slide F).

HELICOMA

Helicoma Corda, Icones Fungorum **1**: 15. *pl. 4, fig. 219.* 1837; Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 45. 1892.

Helicoryne Corda, Icones Fungorum **6**: 9. 1854.

Helicopsis Karsten, Rev. Myc. **11**: 96. 1889.

The type species is *Helicoma Mülleri* Corda.

Conidiophores various. Conidia hyaline, light-colored or fuscous, the filaments spirally coiled, stout in proportion to the length, not hygroscopic. Colonies effuse.

Since Corda originally described *Helicoma*, members properly belonging to the genus have been described, with few exceptions, in the genus *Helicosporium* following Saccardo's treatment. In view of the fact that members of this genus form a more or less homogeneous group of organisms characterized by the thickness of the spore filaments and their non-hygroscopic nature, the writer is following Morgan in restoring the genus to its original status. *Helicoryne* as originally described is obviously synonymous with *Helicoma;* in fact, the type species, *Helicoryne viride*, is a synonym of *Helicoma Mülleri*.

KEY TO THE SPECIES OF HELICOMA

1. Conidial coil 51–72 μ in diameter; filament 28–31 μ in diameter, 6–9-septate. ..... *1. H. roseolum*
1. Conidia smaller 2

2. Coil of conidia 4–7 μ in diameter, filament 1 μ in diameter, hyaline.... *2. H. minutissimum*
2. Conidia larger....3
3. Conidiophore less than 60 μ long in mature plant....4
3. Conidiophore of mature plant more than 60 μ long....8
4. Conidium 7–10 μ in diameter, ¾–1½-times coiled, 1–3-septate, hyaline, on Sphaeropsidae....*3. H. stigmateum*
4. Conidium larger, or at least colored, more frequently septate and coiled....5
5. Diameter of conidial filament 2–2½ μ; of coil 11–12.5 μ; conidia 12–20-times septate....*4. H. microscopicum*
5. Diameter of conidial filament larger....6
6. Conidia tapering to the narrow or truncate basal ends....7
6. Conidia abruptly rounded at basal end....8
7. Conidia coiled 1½–1¾ times, the filament 4.5–5 μ thick, tapering to 1–1.5 μ at base, 8–10–(15)-times septate....*5. H. polysporum*
7. Conidia coiled 2–3 times, 18–21 μ in diameter, multi-guttulate....*6. H. repens*
8. Conidia 20–25 μ in diameter, 2–3-times coiled....*7. H. limpidum*
8. Conidia 11–19 μ in diameter....9
9. Conidia 14.4–19 μ in diameter, 2-times coiled....*8. H. monilipes*
9. Conidia 11–15.5 μ in diameter, 1½–1¾-times coiled....*9. H. olivaceum*
10. Conidia 2–3-times coiled, 16–30-times septate....11
10. Conidia coiled fewer times....13
11. Conidia 36–44 μ in diameter, fuscous, septa deep fuscous..*10. H. perelegans*
11. Conidia smaller, septa hyaline....12
12. Conidia on stout teeth, 2–3 μ in diameter, conidial filament 4–5.4 μ thick....*11. H. violaceum*
12. Conidia on slender teeth, 1.2–2 μ in diameter, and obliquely attached.... *12. H. Morgani*
13. Conidia constricted at the septa, tightly coiled 1½–2 times, fuscous....14
13. Conidia not constricted at the septa....17
14. Conidia less than 30 μ in diameter....15
14. Conidia more than 30 μ in diameter....16
15. Diameter of conidial filament 4.5–5.4 μ....*13. H. phaeosporium*
15. Diameter of conidial filament 5.4–8 μ....*14. H. velutinum*
16. Diameter of conidia 30–35 μ, filament 8 μ....*15. H. intermedium*
16. Diameter of conidia 36–40 μ, filament 11–12 μ....*16. H. palmigenum*
17. Conidia more than 14.5 μ in diameter, if less then more than 4-septate....18
17. Conidia less than 14.5 μ, 4 or fewer septa....25
18. Conidia 30–35 μ, fuscous, with 10–15 dark septa....*17. H. atroseptatum*
18. Conidia smaller, mostly fewer-septate....19
19. Conidia with truncate base, borne on stout (1.5–5 μ in diameter) teeth....20
19. Base of conidia tapering to an apiculate or tapering rounded end, sporogenous teeth less than 1.5 μ in diameter....21
20. Sporogenous teeth 1.5–2.5 μ in diameter, seldom more than once-branched; diameter of conidia 14–19 μ....*18. H. Mülleri*
20. Sporogenous teeth 2–5 μ in diameter, at maturity more than once-branched; diameter of conidia 17–24 μ; "sclerote pedicelée" present..*19. H. proliferens*
21. Conidiophores ascending or repent, much branched; base of conidia abruptly rounded and attached obliquely to the conidiophore....*20. H. ambiens*

21. Conidiophores erect or bent, sparsely branched, or if much branched then more than 6 μ in diameter, and spores not abruptly rounded at base....22
22. Conidiophores erect, conspicuously branched, 6–8 μ in diameter, enveloped in part with a rough sheath. Chile.....*21. H. asperothecum*
22. Conidiophores not as above.....23
23. Conidiophores 5.5 μ in diameter, becoming arcuate, hyaline; conidia 12–18 μ in diameter, yellow in mass. Grenada.....*22. H. conicodentatum*
23. Colonies some shade of brown, fuscous, or black; conidiophores more than 5 μ in diameter, erect, simple, or sparingly branched.....24
24. Diameter of conidial filament 6–8–(10) μ, of conidia 15–20 μ; conidiophores mostly simple, constricted and ascending-arcuate above, with scattered masses of a purplish-black secretion.....*23. H. recurvum*
24. Diameter of conidial filament 4.5–5.4–(7.5) μ; of conidia 14.4–18 μ; conidiophores simple, rarely branched, erect or slightly bent, without masses of secretions or ascending-arcuate terminal portions.....*24. H. Curtisii*
25. Conidiophores 63–243 × 2.8–3.6 μ, without lateral projections; spores 3–5-septate, 12–14.5 μ in diameter.....*25. H. fasciculatum*
25. Conidiophores 27–100 × 3.3–4.5 μ, with blunt, irregularly rounded lateral projections; conidia 3–4-septate, 9–12 μ in diameter.....*26. H. simplex*

1. **Helicoma roseolum** Thaxter, n. sp.

Plate 19, figs. 1–3.

Mycelium scanty and evanescent, hyaline, septate, creeping over upright conidiophores of *Acrothecium* sp., giving rise laterally to branches which occasionally anastomose, generally 21–28 × 4.5–5.4 μ. Conidia acro-pleurogenous on lateral branches of scandent mycelium, tightly coiled, 1¼–1½-times abruptly rounded at distal end, the basal end terminated by a small, slightly tapering cell 7–10 × 7–9 μ, 7–9-septate, not or only slightly constricted at the septa; diameter of conidia at widest point 51–72 μ, of filament 28.8–31 μ.

On rotting fronds of *Euterpe* palm on ground. Grenada.

This beautiful and strikingly characteristic species, collected by Dr. Thaxter, was labelled in his herbarium as *Helicosporium roseolum*, which specific name the writer has adopted here.

In contrast to other members of the genus, the tooth-like projections do not bear the spores, but instead represent the isthmus inserted into the small basal cell of the spore.

Specimen examined:

Grenada, B. W. I.: Grand Etang, *Thaxter, 9*, TYPE (F).

2. Helicoma minutissimum Linder, n. sp.

Plate 19, figs. 4–8.

Colony appearing as inconspicuous whitish pulverulence on the substratum. Conidiophores hyaline, erect, simple or rarely branched, inconspicuously septate, 1–1.5 × 11–15 μ, bearing spores acro-pleurogenously; conidia hyaline, 1–1½-times coiled, 1–3-septate, the distal end bluntly rounded, tapering slightly towards the truncate basal end; diameter of conidial filament .75–1 μ; of coiled spore 4–7 μ.

On decaying elm bark. Massachusetts.

This species need not be confused with any other thus far described since its small size is thoroughly characteristic.

Specimen examined:

United States:

Massachusetts: Waverley, Oct. 14, 1909, *Thaxter*, TYPE (F).

3. Helicoma stigmateum (Reiss) Linder, n. comb.

Lituaria stigmatea Reiss, Bot. Zeit. **11**: 136. *pl. 3, figs. 1–10.* 1853.

Helicomyces niveus Bres. & Jaap, in Jaap, Verh. Bot. Ver. Prov. Brandenb. **58**: 43. 1916.

Helicomyces sphaeropsidis A. Potebnia, Gribnie symbionti. II. Sphaeropsidis i Helicomyces, 21–28, see p. 28. Kharkov, Moscovsk: M. Sergieu i K. Galchenk. 1912.

Plate 19, figs. 9–10.

Colonies minute, white, tufted, confined to region around ostiole of the sphaeropsidaceous substratum or host. Conidiophores either as upright teeth on the hyaline repent mycelium or as erect or bent, simple, hyaline branches 2–3 × 2–2.5 μ. Conidia hyaline, or white in mass, acrogenous, coiled ¾–1½ times, 1–3-septate, the filament 3–3.5 μ thick, tapering from the middle to the rounded base 1½–2 μ in diameter, the distal end bluntly rounded; the coiled spore 7–10 μ in diameter.

Parasitic or saprophytic on fruiting bodies of Sphaeriaceae or Sphaeropsidae.

The type of Reiss's species, *Lituaria stigmatea*, apparently is no longer in existence, from which fact there has been some doubt as to its identity. Von Höhnel[1] even went so far as to place this species in the tropical genus *Delortia*, the fruiting bodies of which are characterized by being gelatinous. If, however, Reiss's figures are compared with those of Potebnia, then the identity of the two species, *H. stigmateum* and *H. sphaeropsidis*, becomes quite evident, since they not only agree in appearance, but also in spore measurements. The fact that Reiss states that the spores are non-septate should not be considered too seriously as an objection since the septa, because of the small size of the spores and their refractive nature, would not be visible except under a high magnification or by the aid of stains. Further evidence of the identity is the similarity of habitat which Reiss states as "auf der Rinde eines dürren, feuchtliegenden Ulmenzweiges, welches von Sphärien bewohnt war." Jaap's material occurred on *Diplodia inquinans* and Potebnia's, otherwise admitted by him to be identical with Jaap's *H. niveus*, is stated to be parasitic on *Sphaeropsis pseudo-diplodia*.

Specimen examined:

Exsiccati: Jaap, O. Fungi Selecti Exsicc., 547.

Germany: Bergedorf, Schleswig-Holstein, *Jaap*, type of *Helicomyces niveus*.

4. **Helicoma microscopicum** (Ellis) Linder, n. comb.

Helicosporium microscopicum Ellis, Torr. Bot. Club Bull. **9**: 98. 1882.

Helicomyces microscopicus (Ellis) Pound & Clements, Minn. Bot. Stud. **9**: 659. 1896.

Plate 19, figs. 11–12.

Producing dense, minute, "Yellow Ochre" tufts. Conidiophores hyaline, erect or bent, up to 30 μ long by 2.7–3 μ in diameter. Conidia acrogenous or pleurogenous, on short hyaline teeth, subhyaline to yellowish, 12–20-times septate, closely 2–2¾-times coiled, the filament 2–2.5 μ in diameter; the coiled spore 11–12.5 μ in diameter.

[1] Von Höhnel, F. Kön. Akad. Wiss. Wien, math.-nat. Kl. Sitzungsber. **125**: 90. 1916.

On decaying catkins of *Alnus serrulata* on ground. New Jersey.

Specimen examined:

New Jersey: Newfield, *Ellis*, TYPE (NY, slide F).

5. Helicoma polysporum Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 46. *fig. 11.* 1892.

Helicosporium polysporum (Morgan) Saccardo, Syll. Fung. **11**: 639. 1895.

Plate 19, figs. 20–25.

Effused, forming a thin, whitish or light rose-colored stratum. Hyphae creeping, hyaline, much-branched. Conidiophores arising as erect or bent, hyaline, ramified branches from the repent sterile mycelium. Conidia hyaline, borne singly on hyaline teeth which may be either solitary or in pairs at the ends of the conidiophores or short branches of the conidiophores, occasionally single and pleurogenous, 8–15-times septate, 1½–1¾-times coiled, the filaments 4.5–5.4 μ thick, gradually tapering from the middle of the first coil towards the slender base, the terminal cell abruptly rounded; diameter of the coiled spore 16–19.8 μ.

On decaying bark. Ohio.

This species differs from all others in this group characterized by having short conidiophores, in that the conidia are broadest towards the distal end, tapering from near the middle of the spore to the very slender (1–1.3 μ in diameter) basal end, thus giving the spore its characteristic appearance.

Specimen examined:

United States:

Ohio: Preston, on inner bark of *Acer saccharinum*, *Morgan*, CO-TYPE (F).

6. Helicoma repens Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 47. *fig. 12.* 1892.

Helicosporium repens (Morg.) Saccardo, Syll. Fung. **11**: 639. 1895.

"Effused, forming a minutely flocculose, pinkish stratum. Hyphae creeping, septate, hyaline, with very short ascending branches, which are covered by the abundant spores. Spores hyaline, multiguttulate, coiled nearly 2½ times; the coil 18–21

mic. in diameter; the thread 80–100 mic. in length, about 4 mic. thick; the inner extremity obtuse, the outer (basal) long and tapering.

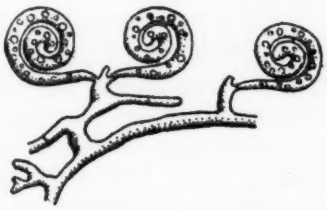

Fig. 9. *H. repens.* After Morgan.

"Growing on the inner bark of *Acer saccharinum*. The hyphae are very fine and creep on or beneath the surface so closely as to be distinguished with difficulty; the colored stratum is formed entirely by the abundant spores. The guttulae sometimes give the spore the appearance of being faintly septate."

7. **Helicoma limpidum** Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 47. *fig. 13.* 1892.

Helicosporium limpidum (Morg.) Saccardo, Syll. Fung. **11**: 639. 1895.

"Effused, forming a minutely flocculose, pale stratum. Hyphae creeping, septate, brownish hyaline, the spores borne at the apex of short lateral branches. Spores hyaline, multiseptate (15–20);

Fig. 10. *H. limpidum.* After Morgan.

the septa sometimes indistinct; coiled 2–3 times; the coil 20–25 mic. in diameter; the thread 80–110 mic. in length, about 4 mic. thick; the inner extremity acute, the outer obtuse.

"Growing on old wood of elm. The outer extremity of the spore does not taper, and is obtuse or sometimes truncate."

8. **Helicoma monilipes** Ellis & Johnson, in Ellis & Everhart, Proc. Acad. Nat. Sci. Phila. **1894**: 376. 1894.

Helicosporium monilipes (E. & J.) Saccardo, Syll. Fung. **11**: 639. 1895.

Plate 19, figs. 17–19.

Colonies appearing as brown, minute tufts less than 1 mm. in diameter. Conidiophores short, up to 55 μ long, 2–4 μ in diameter, subhyaline to dilute fuscous, septate, slightly to strongly constricted at the septa, erect, branched. Spores acrogenous, becoming pleurogenous by the elongation of the conidiophores, subhyaline to dilute fuscous, 2–2¼-times tightly coiled, (7)–10–15-times septate, dark brown, the filament 3.5–5 μ in diameter; the coiled conidium (12)–14.4–19 μ in diameter.

On bark of *Quercus*. Michigan.

Specimen examined:

United States:

Michigan: Ann Arbor, *L. N. Johnson*, Oct. 23, 1893, TYPE (NY and slide F).

9. **Helicoma olivaceum** (Karsten) Linder, n. comb.

Helicopsis olivaceus Karsten, Rev. Myc. **11**: 96. 1889.

Helicopsis punctata Peck, N. Y. State Mus. Bull. **167**: 26. 1912.

Plate 19, figs. 13–16.

Colonies brown, minute tufts less than 1 mm. in diameter. Conidiophores hyaline or dilute fuscous at the base, branched, 10–30 × 2–3 μ. Spores acrogenous, or pleurogenous by the elongation of the conidiophores, dilute fuscous, 1½–1¾-times tightly coiled, the septa black, 3–12; the filament slightly constricted at the septa, 3.6–5.4 μ thick, bluntly rounded at both ends; diameter of the coiled spore 11.7–15.5 μ.

On decaying wood and bark. Europe and America. Rare.

This species strongly resembles the preceding but differs from that in the smaller average size and the fewer turns of the conidia. The type of this species was kindly loaned to the writer by Dr. Harold Lindberg of the University of Helsingfors.

Specimens examined:

Finland: Surikaei, Nov. 1886, *Karsten*, TYPE (H, slide F, MBG).

United States:

New York: Lyndonville, *C. E. Fairman* (NYS, F).

10. Helicoma perelegans Thaxter, n. sp.

Plate 20, figs. 1–2.

Colonies small, .5–1 mm. in diameter, becoming larger by confluence, black. Conidiophores septate, dark brown with subhyaline terminal cells, branched subdichotomously or irregularly, arising singly or in clusters from the fuscous repent mycelium, 3.5–7 × 40–150 μ. Conidia acrogenous, rarely pleurogenous, fuscous except for subhyaline terminal cells, septa dark brown, 16–28; filament tightly coiled 2½–3 times, rarely once-coiled, 7.5–9 μ in diameter, tapering gradually towards the abruptly rounded or truncate basal end and the tapering, rounded distal end; diameter of coil 36–44 μ.

On bark of *Platanus*. Massachusetts. October.

The spores of this species closely resemble those of the Chilean *Helicoma atroseptatum*. The two species may readily be separated, however, by the difference in the size of the conidia and the branched conidiophores of this species.

Specimen examined:

United States:

Massachusetts: Waverley, *Thaxter*, as *Helicosporium perelegans* in herb., TYPE (F).

11. Helicoma violaceum Winter, in herb. n. sp.

Plate 20. figs. 3–5.

Colonies effuse, pulverulent-velvety, pinkish-gray. Conidiophores erect or ascending somewhat irregularly, simple or few-times branched, light fuscous, translucent, hyaline in terminal cells, 22–150 × 4.5–6.5 μ, arising from repent, fuscous sterile mycelium. Conidia hyaline, acro-pleurogenous, borne singly on short, stout, hyaline teeth 2–3.5 μ thick, coiled 2–3 times when mature, septa hyaline, conspicuous, 16–24; diameter of filament 4–5.4 μ, tapering slightly to abruptly rounded distal end and to truncate basal end.

On decaying wood. Germany.

Specimen examined:

Germany: *G. Winter*, TYPE (B, and slide F).

12. Helicoma Morgani Linder, n. nom.

Helicoma Berkeleyi Morgan, nec Curtis, Cinci. Soc. Nat. Hist. Jour. **15**: 48. *fig. 14.* 1892.

Plate 20, fig. 6.

Effused, forming a grayish-brown, loosely hirsute colony. Sterile hyphae creeping, translucent. Conidiophores erect or ascending, at first simple, then loosely and irregularly branching, brownish, translucent, terminal cells hyaline, 27–250 × 3.2–4.5–(5.4) μ. Conidia hyaline, becoming dilute fuscous with age, acropleurogenous, on short, slender teeth 1.2–2.5 μ thick, 18–30-times septate, the septa inconspicuous, 2–3-times coiled; filament 3.6–4.5–(5.4) μ; coil 21–27 μ in diameter.

On decaying wood. Ohio.

In Morgan's original description the diameter of the coiled conidia is given as 25–30 μ, and that of the conidial filament as 5–6 μ. The writer, studying material communicated to Dr. Thaxter by Morgan, found no spores to be over 27 μ in diameter; similarly, the diameter of the conidial filaments to be 3.6–4.5 μ, with an occasional filament measuring 5.4 μ.

Although resembling the preceding species, this one differs in its taller, more slender, and more loosely branched conidiophores; in its smaller conidia; the smaller sporogenous teeth; and by the fact that the conidia are mostly obliquely attached to the teeth.

Specimens examined:

United States:

Ohio: Preston, on rotting wood of *Juglans*, June 12, 1887, *A. P. Morgan*, TYPE (Ia; CO-TYPES F, NY); locality not given, May 12, 1887, May 6, 1888, June 3, 1888, June 28, 1888, Apr. 28, 1889, May 1, 1889, Jan. 1, 1890, Jan. 12, 1890, and Feb. 3, 1890, *A. P. Morgan* (Ia).

13. Helicoma phaeosporium Fresenius, Beitrage **3**: 99. *pl. 10–13, fig. 23–30.* 1863.

Helicosporium phaeosporium (Fres.) Saccardo, Syll. Fung. **4**: 561. 1886.

Helicosporium spectabile Fautrey & Lambotte, Rev. Myc. **17**: 70. *pl. 153, fig. 3.* 1895.

Helicosporium Boydii Smith & Ramsbottom, Brit. Myc. Soc. Trans. **5**: 168. 1915.

Plate 22, figs. 2–5.

Colony effuse, "Olive Brown," minutely hirsute. Conidiophores simple, erect, septate, subulate, fuscous except for hyaline terminal cells, 80–115 × 3–4.5 μ. Conidia acrogenous, rarely pleurogenous, soon deciduous, subhyaline to dilute fuscous, abruptly rounded at both ends, tightly coiled 1½–2 times, 8–12-times septate; filament 4.5–5.4 μ in diameter; diameter of the coiled spore 12.5–20 μ.

Fig. 11. *H. phaeosporium.* After Fresenius.

On decaying wood of coniferous or deciduous trees.

Specimens examined:

Exsiccati: Roumeguere, Fungi Select. Exsicc. 6737, type of *H. spectabile.*

England: West Kilbride, Ayreshire, *Boyd,* type of *Helicosporium Boydii* (BM, slide F).

Austria: *von Höhnel, 2660* (F).

United States:

Massachusetts: Canton, *Linder* (slide F, L).

14. Helicoma velutinum Ellis, Torr. Bot. Club Bull. **9**: 134. 1882.

Helicosporium velutinum (Ellis) Saccardo, Syll. Fung. **4**: 561. 1886.

Plate 22, fig. 1.

Colony effuse, minutely hirsute or velvety, "Olive Brown." Conidiophores erect, simple, septate, subulate, deep brown except for subhyaline terminal cells, 110–125 × 3.5–5.4 μ. Conidia acrogenous, soon deciduous, subhyaline to dilute fuscous, the terminal cells abruptly rounded; the filament more or less tightly coiled 1½–2 times, 10–14-times septate, slightly constricted at the septa, 5.4–8 μ thick; diameter of coiled conidia 18–25 μ.

On Magnolia. New Jersey.

This species, with the preceding and the two following ones,

forms a rather homogeneous group characterized by the simple erect conidiophores and the spores that are tightly coiled, rounded at both ends, and slightly constricted at the septa. They may be separated by their distinctive spore sizes.

Helicoma velutinum has been applied to *Xenosporella Berkeleyi* by Ellis and Morgan as a result of the former author's misdetermination of material sent to him from Louisiana by Langlois. The co-type of *Helicosporium velutinum* in the Farlow Herbarium, however, is the species above described.

Specimen examined:

United States:

New Jersey: Newfield, June, 1882, *Ellis*, CO-TYPE (F).

Fig. 12. *H. intermedium*. After Saccardo.

15. Helicoma intermedium (Penzig & Saccardo) Linder, n. comb.

Helicosporium intermedium Penzig & Saccardo, Icon. Fung. Javan. p. 105. *pl. 71, fig. 4.* 1904.

Colonies effuse, small or confluent, velvety, black. Conidiophores erect, rather stout, filiform, 130–160 × 7–8 μ, multiseptate, fuliginous, pallid above. Conidia acrogenous, dilute fuliginous, the filament coiled 2 times, 14–16-times septate, not constricted, 8 μ thick; diameter of the coiled conidia 30–35 μ.

On decaying culms of bamboo, Mar. 14, 1897.

The above description is a translation of the original. In view of the figure accompanying the description and the distinctive size and shape of the spores, there should be no doubt as to the identity of this species.

16. Helicoma palmigenum (Penzig & Saccardo) Linder, n. comb.

Helicosporium intermedium var. *palmigenum* Penzig & Saccardo, Icon. Fung. Javan. p. 105. 1904.

Colonies effuse, small or confluent, velvety, black. Conidiophores erect, rather stout, filiform, fuliginous, pallid above.

Conidia acrogenous, dilute fuliginous, the filament coiled two times, 10–12-times septate, the filament 11–12 μ thick and forming a coil 36–40 μ in diameter.

On decaying petioles of palms, Horto. Bogor., Dec. 18, 1896.

This specimen, because of the distinctly greater dimensions and the fewer septa of the spores, should be considered a species distinct from *Helicoma intermedium*, and is so recognized here.

17. Helicoma atroseptatum Linder, n. sp.

Plate 23, figs. 7–9.

Effuse, forming a dark brown, hirsute colony. Repent mycelium fuscous, septate, branched. Conidiophores simple, erect or somewhat irregularly bent, occasionally tending to become fasciculate, deep fuscous, the apical cells subhyaline to hyaline, 150–310 × 6.3–7.2 μ, gradually tapering upwards to the thick (2.5–3.6 μ) rounded terminal cells. Conidia pleurogenous on stout, simple or once-branched hyaline teeth, 2.3–3 × 3.6–7 μ, 1¼–2-times tightly coiled, fuscous except for the basal, and frequently the distal, cells, 10–16-times septate, the septa black, the filament 8–11 μ thick, tapering to the truncate basal cell, the terminal cell abruptly rounded; diameter of the coiled conidia 30–35 μ.

On decaying wood and bark. Chile.

This species grows in company with *Helicoma asperothecum*, from which it is readily distinguished by the simple, erect conidiophores and by the characters of the conidia. It most closely resembles *Helicoma perelegans* in its conidial characters, but again the simple erect habit of the conidiophores of this species separates the two.

Specimen examined:

Chile: Correl, on logs in open clearing, December, *Thaxter*, TYPE (F).

18. Helicoma Mülleri Corda, Icones Fung. **1**: 15. *pl. 4, fig. 219.* 1837.

Helicoryne viride Corda, Icones Fung. **6**: 9. *pl. 3, fig. 38.* 1854.

Helicosporium Mülleri (Cda.) Saccardo, Michelia **2**: 129. 1880.

Helicosporium brunneolum Berkeley & Curtis, Grevillea **3**: 51. 1874.

Helicosporium viride (Cda.) Saccardo, Syll. Fung. **4**: 558. 1886.

Helicomyces Mülleri (Cda.) Pound & Clements, Minn. Bot. Studies **9**: 658. 1896.

Helicomyces brunneolus (B. & C.) Pound & Clements, Minn. Bot. Studies **9**: 658. 1896.

Plate 21, figs. 12–20.

Colonies forming an effuse, hirsute, "Citrine Drab" to "Dark Olive Buff" layer. Sterile hyphae creeping, septate, giving rise to erect or suberect, simple or little-, rarely much-, branched conidiophores. Conidiophores translucent, brown at the base, lighter towards the abruptly rounded, subhyaline apices, 45–150 × 5.4–7.2 μ, septate, the septa mostly 9–14.4 μ apart. Conidia pleurogenous, occasionally acrogenous on simple or once, rarely more frequently, branched, stout (1.5–1.8 × 1.8–5.4 μ), cylindrical teeth, 1½–1¾-times coiled, the filament hyaline to dilute fuscous, (5)–7–9–(11)-times septate, 3.6–5.4 μ thick, bluntly rounded at the distal end, tapering to the truncate basal end; diameter of the coiled conidia (14)–16–19 μ.

On decaying bark or wood of deciduous trees.

The names *Helicoma Mülleri* and *H. Curtisii* have been used more or less interchangeably for the two species. They are, however, separated by quite distinct characters of the conidia and conidiophores. *Helicoma Mülleri* is characterized by the somewhat translucent, closely septate conidiophores with abruptly rounded apices; by the conspicuous, stout sporogenous teeth borne laterally on the conidiophores; and by the truncate basal cell of the conidia. *Helicoma Curtisii* is characterized by the very dark, more distantly septate conidiophores of which the apices are rounded-tapering; the inconspicuous sporogenous teeth; and by the acrogenous conidia with the tapering-rounded, recurved basal ends. The type of *Helicosporium brunneolum* differs in no way from this species, although the conidia were lacking; the conidiophores are typical of those of *Helicoma Mülleri*.

Specimens examined:

Exsiccati: Roumeguere, Fungi Gall. Exsicc., 2133; Bartholomew,

Fungi Columb., 1624; Ellis, Fungi N. J., 3163; Cooke, Fungi Brit. Exsicc. 2nd ed., 447; Jaap, Fl. d. Prov. Brandenb.; Vize, Microfungi Brit., 62.

England: Forden, *J. E. Vize*, in Cooke, Fungi Brit. Exsicc.; North Whitby, Sept. 1900, *S. Crossland* (K).

France: Isere, *J. Thiery, 6508*, in Roumeguere, Fungi Gall. Exsicc; Montmorency, *Boudier, 900* (P).

Germany: Brandenburg, Aug. 1908, *O. Jaap* (B).

United States:

Maine: York, Mt. Agamenticus, on *Quercus*, Sept. 20, 1892, *Thaxter* (F); York, on *Acer rubrum*, Sept. 2, 1891, Sept. 22, 1892, and Sept. 1896, *Thaxter* (F); Kittery Point, on *Pyrus Malus*, Sept. 19, 1892, and on *Quercus*, Aug. 1920, *Thaxter* (F).

Massachusetts: Canton, on chestnut bark, *Linder, 745,1002*; on poplar, Nov. 1924, *Linder* (L); Waverley, on *Acer rubrum*, *Thaxter* (F).

Connecticut: West Haven, Nov. 4, 1888, and Nov. 10, 1888, *R. Thaxter* (F); New Haven, on *Acer*, Sept. 1920, *Thaxter* (F).

New York: Karner, on fallen limbs of *Populus grandidentata*, Oct. 1928, *H. D. House* (MBG 54378).

New Jersey: Newfield, on maple, *J. B. Ellis*, in Fungi N. J.

19. Helicoma proliferens Linder, n. sp.

Plate 22, figs. 6–10; plate 31, fig. 6.

Colonies "Sepia" to "Brownish Olive," round to elongate, 1–4 mm. broad, larger by confluence, finely hirsute. Conidiophores simple or rarely branched, occasionally anastomosing, fuscous except for subhyaline terminal cells, septate, 75–175 × 5–6.5 μ, bearing laterally stout, hyaline to subfuscous, simple or branched teeth 2–5 μ thick. Conidia hyaline, 3–7–(11)-times inconspicuously septate, the filament coiled 1¼–2-times, 5–6.5–(7) μ in diameter, tapering towards the truncate basal end, bluntly rounded at the distal end; the coiled spore 17–24 μ in diameter.

On decaying bark of *Acer*. Connecticut.

This species closely resembles *Helicoma Mülleri* both in the characters of the conidia and conidiophores. The conidia differ from those of the preceding species in that the diameter of the

conidial filament is larger, as is also the diameter of the coiled spore. The proliferating teeth, also, make an additional point of difference. Furthermore, there are present in the type collection, the "sclerote pedicelée" shown in fig. 6 of plate 22.

Specimen examined:

United States:

Connecticut: West Haven, Nov. 10, 1888, *R. Thaxter*, TYPE (F).

20. Helicoma ambiens Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 46. *fig. 10.* 1892.

Plate 21, fig. 11; plate 23, figs. 1–3.

Helicosporium ambiens (Morg.) Saccardo, Syll. Fung. **11**: 639. 1895.

Colony an effuse, hirsute, "Sepia" layer. Sterile mycelium repent, fuscous, septate, and branching. Conidiophores bent-ascending, occasionally repent, branched, occasionally anastomosing, fuscous except for dilute fuscous terminal cells, 3.5–6 μ in diameter and up to 200 μ long. Conidia acro-pleurogenous, borne singly on short, inconspicuous hyaline teeth, the filament hyaline to dilute fuscous, tightly coiled 1½–1¾ times, 6–8-times septate, 5.4–6.3 μ thick; coiled conidia 18–20 μ in diameter.

On decaying bark. Ohio.

Morgan says of this species that the spores are at first hyaline and continuous and that the septa appear one after another until the spore is 8-septate. In older specimens the spores become brownish-tinged and have added a few half septa so as to appear 9–12-septate.

Although this species very closely resembles *Helicoma Curtisii*, it is characterized by its branching habit. It may also be separated from that species by the additional characters of the conidia; the conidia of *H. Curtisii* having recurved, rounded-tapering basal ends, while those of *H. ambiens* are recurved and bluntly rounded, as will be seen in fig. 11 of plate 21 and fig. 3 of plate 23. The real status of this species can only be determined by comparative cultural studies or else by connecting it with the perfect stage.

Specimens examined:
United States:
Ohio: Preston, *A. P. Morgan*, CO-TYPE (F); TYPE (Ia?).

21. Helicoma asperothecum Linder, n. sp.

Plate 23, figs. 4–6.

Colonies hirsute or stiff-velvety, "Sepia" to almost black, effuse. Conidiophores at first erect, simple, later loosely branched, anastomosing, and tending to become loosely fasciculate, fuscous with dilute fuscous or subhyaline terminal cells, the younger cells granulate-roughened by crystal-like deposits, or the older covered with a deposit of colored crystalloid material, 55–250 × 5.5–7.5 μ. Conidia hyaline to dilute fuscous, acro-pleurogenous on slender, hyaline, cylindrical teeth 1 × 1–2 μ; conidial filament 1½–1¾-times coiled, 8–10-septate, 4.5–6.5 μ thick, tapering slightly towards the bluntly rounded distal end and towards the slightly recurved rounded-tapering basal end; the coiled conidia 15–18 μ in diameter, immature spores as small as 10 μ in diameter.

On decaying bark and wood. Chile.

This species, although resembling *Helicoma Curtisii* and *H. ambiens*, differs from them in many respects. It differs from both by the roughened walls of the conidiophores; from *H. Curtisii* in its branching habit, the shorter spaces between the septa, and the slight constrictions; from *H. ambiens* by the taller and more robust conidiophores, their more erect habit, and the more numerous septa and the tapering, slightly recurved, bluntly pointed basal end of the conidia.

Specimen examined:
Chile: Correl, *R. Thaxter*, TYPE (F).

22. Helicoma conicodentatum Linder, n. sp.

Plate 24, figs. 5–6.

Colonies small, effuse, somewhat arachnoid, "Olive Ocher" to "Olive Yellow." Conidiophores less than 5 μ in diameter, fuscous in the basal portions, hyaline at the extremity, at first simple, erect, then branched, becoming elongate, bent, and tenuous, producing lateral conical swellings on the lower portions, these bearing spores on slender sporogenous teeth. Conidia in

the younger stages acrogenous, later pleurogenous, hyaline to dilute yellowish ochraceous, the conidial filament 1¼–1¾-times tightly coiled, 5–7-septate, 5–5.5 μ thick, bluntly rounded at the distal end, rounded-tapering at the frequently apiculate basal end; diameter of the coiled conidia 14–17.5 μ.

On decaying wood. Grenada.

Specimen examined:

Grenada, B. W. I.: Grand Etang, *Thaxter*, TYPE (F).
Trinidad, B. W. I.: Maraval Valley, *Thaxter* (F).

23. Helicoma recurvum (Petch) Linder, n. comb.

Helicosporium recurvum Petch, Roy. Bot. Gard. Peradeniya, Ann. **10**: 138. 1926.

Plate 24, figs. 7–11.

Colonies black, hirsute, effuse, more or less circular. Conidiophores clustered or gregarious, up to 200 μ long, 6–8 μ thick, fuscous except for subhyaline terminal cells, septate, with scattered superficial masses of purplish-black crystalloid deposits, occasionally constricted above and the upper cells often ascending-arcuate. Conidia hyaline or dilute fuscous, acro-pleurogenous, (3)–6–8-septate, not constricted at the hyaline septa, 1–1¾-times coiled, the filament 6–8–(10) μ thick, bluntly rounded at the distal end, rounded-tapering and recurved at the basal end, coiled conidia 15–17–(20) μ in diameter.

On dead mango branches, Ceylon.

H. recurvum closely resembles *H. Curtisii*. The spores of the former, however, are characterized by their thicker filaments which measure 6–8 μ as against 4.5–6.5 μ of *H. Curtisii*. Additional characters for the separation of the two species are to be found in the conidiophores. The lateral sporogenous teeth are more pronounced in this species, and the constrictions and the ascending-arcuate terminal portions of the conidiophores, together with the purplish-black deposits, give additional means for separating the two species.

Specimen examined:

Ceylon: Peradeniya, *T. Petch, 4334*, TYPE (K, Pe, and slide F).

24. Helicoma Curtisii Berkeley, Grevillea **3**: 106. 1875.

Helicosporium Curtisii (Berk.) Saccardo, Syll. Fung. **4**: 560. 1882.

Helicomyces Curtisii (Berk.) Pound & Clements, Minn. Bot. Studies **9**: 659. 1896.

Helicosporium Tiliae Peck, Torr. Bot. Club Bull. **34**: 103. 1907.

Plate 21, figs. 1–10; plate 30, fig. 1; plate 31, fig. 2.

Colonies effuse, hirsute, "Brownish Olive" to "Sepia." Conidiophores erect, simple or rarely branched, up to 200 μ long, 5.4–7.2 μ thick, slightly flexuous, deep fuscous except for the lighter-colored, obtusely rounded-tapering terminal cells. Conidia acrogenous, less frequently pleurogenous, on short slender, inconspicuous teeth, subhyaline to dilute fuscous, 1¼–1¾-times coiled, 4–9-septate, the filaments 4.5–5.4–(7.5) μ thick, the base tapering-rounded and somewhat recurved; diameter of the coiled spore 14.4–18–(20) μ.

On decaying wood and bark of deciduous trees. Early spring to late fall. Europe, and the United States west to Missouri.

Helicoma Mülleri, as is stated in the discussion under that species, has been confused with this. The type specimen of *Helicosporium Tiliae* from Missouri differs from *H. Curtisii* only in the slightly larger spores, the filaments of which are 6.3–7.2 μ thick, and the diameter of the coiled spores varies from 16.2 to 20 μ. Since the spores are alike in all other respects, it seems advisable to classify that species under *Helicoma Curtisii*, especially in view of the fact that in the specimen from Florida, collected by Dr. Thaxter, the spores were even larger, the diameter of filament being 7–8 μ and of the coiled spore 18–22 μ. This specimen, however, was found to be connected with a perfect stage which agrees in all details with *Lasiosphaeria pezizula*, the ascigerous phase in the life history of *Helicoma Curtisii*, as has been demonstrated in Part I of the present paper.

Specimens examined:

Exsiccati: Roumeguere, Fungi Select. Exsicc., 5499, as *Helicosporium vegetum;* Ellis, N. Am. Fungi, 967; Ravenel, Fungi Exsicc., 305.

France: Saint-Bonnet-le-Froid, Dec. 1887, *J. Thierry*, in Roumeguere, Fungi Select. Exsicc.

United States:

Maine: Kittery Point, with *Lasiosphaeria pezizula, Thaxter;* Aug. 1891, *Thaxter* (F); York, on bark of *Populus, Thaxter* (F).

New Hampshire: Bartlett, April, 1901, *Thaxter;* Intervale, on *Acer*, Aug. 1901, *Thaxter* (F).

Massachusetts: Canton, *Linder, 1209*, with *Lasiosphaeria pezizula, 1341, 1047* (L); Sharon, on white oak bark, *A. P. D. Piguet* (F); Lexington, on apple, *Thaxter* (F); Waverley, *Thaxter* (F).

Connecticut: West Haven, on *Acer*, Nov. 1888, *Thaxter;* Tyler City, *Thaxter* (F).

South Carolina: Aiken, *H. W. Ravenel*, in Ellis, N. Am. Fungi.

Florida: Cocoanut Grove, on dead stem of Oleander, with *Lasiosphaeria pezizula, Thaxter* (F); on decaying wood, January, 1898, *Thaxter* (F).

Missouri: Emma, September, 1906, *Demetris*, type of *Helicosporium Tiliae* (NYS, slide MBG, F).

The perfect stage of this fungus is *Lasiosphaeria pezizula.* The description follows:

Lasiosphaeria pezizula (B. & C.) Saccardo, Syll. Fung. **2**: 195. 1883.

Sphaeria pezizula Berkeley & Curtis, Grevillea **4**: 106. 1876.

Herpotrichia pezizula (B. & C.) Ellis & Everhart, N. Am. Pyrenomycetes, p. 160. 1892.

Perithecia gregarious, black, smooth at maturity, pear-shaped when moist, concave or cup-shaped when dry, 350–400 μ in diameter. Asci clavate to broad-clavate, 18–27 × 107–155 μ, the distal end thickened, each end penetrated by a single pore through which the ascospores escape. Spores secreted in a mass at the mouth of the ostiole, at first hyaline and then dilute fuscous, 5–7-septate, 30–55 × 5–7 μ, straight or slightly curved, tapering from the middle towards the rounded or somewhat pointed ends.

Habitat as in the imperfect stage.

Ellis and Everhart report the ascospores as being occasionally 8–10 μ thick, and further state that "Cooke in his Synopsis places this among the brown-spored species, but we have always found the sporidia hyaline." This statement is an additional example of the confusion that is likely to arise when color is used as a basis for the separation of genera. The spores of this species when first extruded are, as Ellis and Everhart point out, hyaline,

but when they have been exposed to the air only a few days, they become light fuscous, even though viewed under the microscope.

Specimens examined in which the perfect and imperfect stages occur together:

United States:

Maine: Kittery Point, *R. Thaxter* (F).

Massachusetts: Canton, *Linder, 1209* (F, L, MBG).

Florida: Cocoanut Grove, *R. Thaxter* (F).

25. Helicoma fasciculatum Berkeley & Curtis, in U. S. North Pacific Exped., No. 142.

Helicosporium fasciculatum (B. & C.) Saccardo, Syll. Fung. **4**: 560. 1886.

Helicomyces fasciculatus (B. & C.) Pound & Clements, Minn. Bot. Studies **9**: 658. 1896.

Plate 24, figs. 3–4.

Colonies as small, brownish-black, circular patches on the under side of leaves. Conidiophores arising in clusters from gatherings of dark hyphae in the substratum, erect or slightly flexuous, simple, fuscous, the apical cells subhyaline, 63–243 × 2.8–3.6 μ, the conidia acrogenous, produced singly or in pairs, at first hyaline then dilute fuscous, 3–5-septate, a dark line being formed on either side of the septa, spore filament 7.2 μ thick, once-coiled to form conidia 12.5–14.5 μ in diameter.

On the under side of dead leaves, Loo-Choo Islands, Japan. This species is also reported from California by Harkness[1] on leaves of *Laurus* sp.

Specimen examined:

Exsiccati: U. S. North Pacific Expedition, under Commanders Ringgold and Rogers, 1853–56. Loo-Choo Islands, Japan, *C. H. Wright, 142*, TYPE.

26. Helicoma simplex (Sydow) Linder, n. comb.

Helicosporium simplex Sydow, Herb. Boissier Mem. **4**: 7. 1900.

Plate 24, figs. 1–2.

[1] Harkness, H. W., in Cooke & Harkness, Grevillea **9**: 85. 1881.

Colonies as brownish-black circular patches on the under side of leaves. Conidiophores arising in clusters from gatherings of dark hyphae in the substratum, erect or ascending, simple or rarely branched, fuscous, the terminal cells hyaline, 27–100 × 3.3–4.5 μ, the tip inflated and bearing conidia singly. The conidia at first hyaline, then dilute fuscous, apical or occasionally lateral on swellings of the conidiophores, 3–4-septate, the septa bordered on either side by dark lines, once-coiled, flat, the filament 5–6 μ thick; the conidia 9–12 μ in diameter.

On under side of leaves of *Daphniphyllum macropodium*. Japan.

This species differs from *Helicoma fasciculatum* in its shorter, more robust, and lighter-colored conidiophores; by the presence of lateral swellings on these, resulting from their continued growth after the first spores have been produced; and also by the fact that the spores, smaller in size, are borne singly. This species and the preceding are quite characteristic and form a group which appears to be oriental. The spores of *Helicostilbe simplex* resemble those of the two above species; the conidiophores, however, are aggregated to form the stelar structure characteristic of the Stilbaceae.

Specimen examined:

Japan: Nishigahara, *Kusano*, TYPE (S, slide F).

SPECIES IMPERFECTLY KNOWN

Helicoma candidum (Pr.) Linder, n. comb.

Helicotrichum candidum Preuss, Linnaea **24**: 111. 1851.

Helicomyces candidus (Pr.) Saccardo, Syll. Fung. **4**: 234. 1886.

Plate 24, fig. 12.

"Thallo effuso albo; sporis flocciformibus, apice et lateribus surculatis, spiraliter convolutis septatis diaphanis albis.

"Habitat in asseribus antiquis, foliisque dejectis Pini. Hoyerswerda."

In the original description given above there is little to identify this species. Fresenius[1] gives a more ample definition of the species as follows:

[1] Fresenius, G. Beitrage z. Myk. 3: 101. *pl. 12, fig. 31–33.* 1863.

"Preuss theilt in der Linnaea von 1851 dieser seiner neuen Art, welche ich aus Rabenhorst's herbar. mycol. Nr. 1434 kenne, einen thallus effusus albus zu. An den mir vorliegenden Exemplaren konnte ich einen Träger der Sporen nicht auffinden; er ist vielleicht nur sehr kurz, wohl auch zart und vergänglich. Die Sporen sind 1/60–1/40 mm. gross, weiss, mit einem kurz vorgezogenen abgestutzten Spitzchen. Scheidewände öfter schwer wahrzunehmen, nicht so zahlreich wie bei dem vorigen Pilz [*Helicoma phaeosporium*]; ich zählte deren 3–5, seltner auch wohl fast die doppelte Anzahl. Figur 31–33 [above] sind drei Sporenexemplare nach einer 350 maligen Vergrösserung abgebildet."

Fig. 13. *H. candidum.* After Fresenius.

In number 1434 of Rabenhorst's 'Herbarium Mycologicum' at the Farlow Herbarium, the writer was able, after diligent searching, to find but one spore, and this corresponded very well with that figured by Fresenius. That the species is neither a *Helicomyces* nor *Helicotrichum* is clearly shown by the relative stoutness of conidial filament which definitely places the species in this genus. Unfortunately, owing to the lack of details concerning the conidiophores, it is impossible to give the species a definite place among the other better-known ones, although, because of its habitat and the nature of its spores, it appears to be quite distinct. The following are the characters noted for the one spore: spore hyaline, once-coiled, 3-septate, the filament 9 μ thick, rounded-tapering to a somewhat truncate basal end, the distal end bluntly and obtusely rounded; diameter of the coiled conidium 18 μ.

XENOSPORELLA

Xenosporella von Höhnel [ed. Weese], Centralbl. f. Bakt. Abt. II. **60**: 17. 1923.

Helicoma Sacc. nec. Corda, Saccardo, Syll. Fung. **11**: 638. 1895.

Colonies stiff-velvety, brown or black. Conidiophores short, stout, hyaline to deep fuscous, branched. Conidia 1–1½-times coiled, dilute fuscous to deep fuscous, the filament thick, non-hygroscopic, longitudinally and transversely septate.

The type species is *Xenosporella pleurococca*.

The fundamental character of this genus is the longitudinally and transversely septate spores. Until von Höhnel established this genus, the species were classified under *Helicoma*, *Helicosporium*, and *Helicomyces*.

KEY TO THE SPECIES OF XENOSPORELLA

1. Conidia 38–55 μ in diameter, deep fuscous to opaque and black..*3. X. Thaxteri*
1. Conidia less than 35 μ in diameter....2
2. Mature conidia fuscous to deep fuscous, the filament coiled around a central cell....3
2. Mature conidia subhyaline to dilute fuscous, the filament not, or rarely, coiled around a central cell....*4. X. larvalis*
3. Conidiophores hyaline to subhyaline, or if fuscous, only at the base....*1. X. pleurococca*
3. Conidiophores deep fuscous....*2. X. Berkeleyi*

1. Xenosporella pleurococca von Höhnel [ed. Weese], Centralbl. f. Bakt. Abt. II. **60**: 17. 1923.

Plate 25, figs. 1–5.

Colonies effuse, short-velvety, dusty-gray to black. Sterile mycelium repent, fuscous or brown, septate, branched. Conidiophores hyaline or subhyaline, stout, erect, branching below, 18–45 × 3.5–4.5 μ. The conidia acrogenous, at first subhyaline, at maturity becoming fuscous, ¾–1-coiled, longitudinally and transversely septate, dividing the conidium into 13–16 cells, the filaments 12.5–17 μ thick, coiled around darker-colored central cells, the coiled conidia 24–30 μ in diameter.

On decaying wood of *Populus*. Austria.

Specimen examined:

Austria: Sonntagsburg, *von Höhnel, 2664*, TYPE (F).

2. Xenosporella Berkeleyi (Curtis) Linder, n. comb.

Helicoma Berkeleyi Curtis, Am. Jour. Sci. II. **6**: 352. 1848.

Helicoma binale Curtis, in Berkeley & Curtis, N. Am. Fungi, 3297.

Helicoma binale var. *apertum* Curtis, *Ibid.*

Helicosporium Berkeleyi (Curtis) Saccardo, Syll. Fung. **4**: 560. 1886.

Helicosporium binale (Curtis) Saccardo, *Ibid.*

Helicosporium diplosporum Ellis & Everhart, Acad. Phila. Proc. **1891**: 93. 1891.

Helicomyces diplosporus (E. & E.) Pound & Clements, Minn. Bot. Studies **9**: 659. 1896.

Helicoma bambusae P. Hennings, Hedwigia **41**: 310. 1902.

Plate 25, figs. 6–11.

Colony effuse, coarsely granular to short, coarse-velvety, olive-black to black. Conidiophores much-branched, septate, dark brown, short and stout, 36–144 × 3.6–7.2 μ. Spores acrogenous, dilute fuscous to very deep fuscous, ¾–1-coiled, longitudinally and transversely septate, dividing the spores into 13–22 cells, the filaments 9.5–11.5 μ thick, coiled around darker central cells, the coiled conidia 23–27 μ in diameter.

On bark and wood of deciduous trees and vines, and on bamboo. Southern United States, the West Indies, and Brazil. Also reported from India.

This tropical or subtropical species, because of its exceptional appearance, has received a number of names. An examination of the types of *Helicosporium diplosporum* and of *Helicoma bambusae* indicates that all these species are identical with the type of *Helicoma Berkeleyi* and are synonymous. *Helicoma binale* and its variety *apertum* were distributed by Curtis in the 'North American Fungi,' but were not actually published until they appeared in the 'Sylloge Fungorum.' Curtis, however, did publish *H. Berkeleyi*, and in a subsequent number of the 'American Journal of Science'[1] stated that the species and variety were the same as *H. Berkeleyi* which he published earlier. He also tentatively proposed the new genus *Systrephium* but failed to describe it.

Specimens examined:

Exsiccati: Ravenel, Fungi Caroliniani, IV, 85.

United States:

South Carolina: Society Hill, on *Cornus florida, Curtis*, **TYPE** (F, BM, P); on *Platanus, Ravenel, 3297*, as *Helicoma binale* (BM); Pinesville, on *Liquidambar, Ravenel, X4;* no locality, on *Rhus radicans, Ravenel, 1203* (BM).

[1] Curtis, M. A. Am. Jour. Sci. II. **6**: 444. 1848.

Georgia: Darien, on *Arundinaria*, *Ravenel*, *2508* (BM); on *Liquidambar*, *Ravenel*, *3210* (BM).

Florida: Gainesville, on *Carpinus*, *Ravenel*, *89* (BM); on *Aralia spinosa*, *Ravenel*, *112* (BM); Cocoanut Grove, on dead stems of Oleander, *Thaxter* (F); Grasmin, on old palmetto, *Sturgis*, as *Helicoma larvale* (F).

Alabama: Montgomery, *Burke*, *368* (MBG).

Tennessee: Burbank, on *Cornus*, *Thaxter* (F).

Louisiana: St. Martinsville, on *Vitis vulpina*, *Langlois*, type of *Helicosporium diplosporum*, also under the name of *Helicoma velutinum* (F).

Bermuda: on palmetto, Acad. Nat. Sci. Phila. Expl. Bermuda, 1380-C, as *Helicoma larvale* (NY).

Trinidad: Port-of-Spain, Maraval Valley, on bamboo, *Thaxter* (F).

Brazil: Sao Paulo, on bamboo, *Putteman*, *350*, type of *Helicoma bambusae* (B, S).

A perfect stage, *Melanomma helicophilum* (Cke.) Sacc., was suggested by Cooke[1] as being connected with *Helicoma Berkeleyi*, but such a connection is extremely doubtful, as is also the identity of the ascigerous stage. Berlese[2] states in regard to *Melanomma helicophilum*, "Ex specim. orig. nihil eruere potui. Certe ut videtur species non ad *Melanomma* pertinet." The writer was unable to find *Sphaeria helicophila* Cke. (*Melanomma helicophila*) in Ravenel's 'Fungi Americani,' although in his 'Fungi Carolini-ani' a perfect stage was found with the material labelled *Helicoma Berkeleyi*. This proved to be *Lasiosphaeria pezizula*, and with it, although *H. Berkeleyi* was also present, were the conidiophores of *Helicoma Curtisii* forming a part of the thin subiculum. Conidia of the latter were also present. It therefore would appear from above evidence that *Sphaeria helicophila* Cke., *Byssosphaeria helicophila* Cke., and *Melanomma helicophilum* (Cke.) Sacc. are identical with *Lasiosphaeria pezizula* (B. & C.) Sacc. and should be considered synonymous with that species.

3. **Xenosporella Thaxteri** Linder, n. sp.

Plate 25, figs. 16–24.

Colonies effuse, black, coarsely pulverulent. Conidiophores

[1] Cooke, M. C. Grevillea 6: 145. 1878.

[2] Berlese, A. N. Icones Fung. 1: 38. 1890.

hyaline to subfuscous, arising from branched, repent, subfuscous mycelium, 15–25 × 4–5.4 μ. Conidia acrogenous or apparently pleurogenous on short, tooth-like branches, transversely septate, and somewhat spirally coiled, at maturity becoming 28–65-celled from the longitudinal and transverse septa, deep brown to opaque brownish-black, hyaline when immature, tapering from 20–25 μ at the center to 10–13 μ at the thick truncate basal end, and to the rounded acuminate, often hyaline, distal cell, the coiled conidia 37–57 μ in diameter. Secondary conidia hyaline, pear-shaped, 2-celled, the basal cell smaller, 11 × 19.5 μ, borne acrogenously on fuscous, simple, septate conidiophores, 80–100 × 3.6–4.5 μ.

On dead *Costus spiralis* stems. Trinidad, B. W. I.

This species is dedicated with great pleasure to Dr. Roland Thaxter of Harvard University, not only because he collected it, but also as a token of gratitude for the privilege of studying his extensive collection of helicosporous forms.

It is scarcely necessary to say anything further of this remarkable and striking species. Its characters are sufficiently definite to preclude the possibility of its being confused with any species heretofore described. It should be mentioned, however, that there is evidence of further polymorphism, but since this could not be proven definitely, it seems advisable to pass over the doubtful stages with the hope that this species will again be collected and will then be grown in culture. In association, although not definitely connected with the above species, is a perithecial stage which is described as follows:

Acanthostigmella Thaxteri Linder, n. sp.

Perithecia solitary or widely scattered, rounded pear-shaped, 90 × 79 μ, peridium leathery, dilute fuscous, the ostiole encircled by an irregular row of short, stout, erect, bent or recurved bristles, 27–36 × 3.6 μ. Asci 36–45 × 7.2 μ, 8-spored. Spores 4–5-septate, at first hyaline, then subfuscous, straight or slightly curved, 15–20 × 3–3.5 μ, broadest at the middle, rounded at the ends.

Specimen examined:

Trinidad, B. W. I.: Maraval Valley, Port-of-Spain, on dead *Costus spiralis, Thaxter*, TYPE (F).

4. **Xenosporella larvalis** (Morgan) Linder, n. comb.
Helicoma larvale Morgan, Cinci. Soc. Nat. Hist. Jour. 15: 45. *fig. 9.* 1892.

Plate 25, figs. 12–15.

Colony effuse, thin, pulverulent, dirty gray or brownish. Conidiophores branched, septate, hyaline or dilute fuscous above, light fuscous to fuscous at the basal cells, short, stout, up to 75 μ long, 3.2–4.5 μ thick, arising from fuscous repent, septate, and branched sterile hyphae. Conidia acrogenous, hyaline to dilute fuscous in the old spores, once-coiled, longitudinally and transversely divided into 15–18–(20) cells by colored septa, the filament 6.5–8 μ thick, abruptly rounded at the distal end, and tapering to a broad truncate basal end, rarely coiled around a central hyaline cell; diameter of coiled spore 15.5–20 μ.

On decaying woody substances. Ohio and North Carolina.

This species, because of the hyaline to subhyaline conidia which are divided by dark septa and because of the dimensions of the conidia and conidiophores, is quite distinct from other members of the genus. Doubt as to the identity of the species has resulted from the fact that Morgan distributed or determined a few specimens under this name which in reality are obviously *X. Berkeleyi.* Material kindly communicated to me by Dr. G. W. Martin from the Morgan herbarium in the University of Iowa, however, definitely decides the status of this species.

Berlese[1] has figured *Chaetosphaeria parvicapsa* (Cke.) Sacc. as the perfect stage of this species. The measurements of the conidia are slightly larger than those given here. He states that the conidia of his material, collected in Aiken, North Carolina, measure 18–22 μ in diameter.

Specimen examined:

United States:

Ohio: on inner bark of *Acer saccharinum, A. P. Morgan,* TYPE (Ia, and slides F, MBG).

HELICOON

Helicoon Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 50. 1892; Saccardo, Syll. Fung. **11**: 609. 1895; Lindau, in Engl. & Prantl,

[1] Berlese, A. N. Icones Fung. 1: 27. *pl. 17, fig. 4.* 1890.

Nat. Pflanzenfam. **1** (1**): 452. 1900; Lindau, in Rabenhorst, Kryptog. Fl. Deutschl. Öst. u. d. Schweiz 1^8: 535. 1906; 1^9: 277. 1908.

Type species is *Helicoon sessile* Morgan.

Conidiophores various, erect, simple or branched, or apparently obsolete. Conidia hyaline, bright-colored, or fuscous, the filament coiled in 3 planes to form a cylindrical or ellipsoidal body, never in chains.

Before the creation of this genus, members of the group were classified under *Helicoryne*, *Helicomyces*, and *Helicosporium*. As at present constituted, *Helicoon* is a homogeneous group characterized by the cylindrical or ellipsoidal spore bodies and shows no transitional tendencies towards any other genera with the exception of *Helicodendron*, from which genus it is separated by the conidia not being in chains, but produced singly. It should be emphasized that a very careful examination should be made to determine this point, since in certain species of *Helicodendron*, the spores fall apart very readily.

KEY TO THE SPECIES OF HELICOON

1. Conidiophores less than 50 μ long.....2
1. Conidiophores more than 50 μ long.....4
2. Conidia fuscous, 50–60 × 50–80 μ.....*1. H. Richonis*
2. Conidia hyaline, smaller.....3
3. Conidia 25–27 × 23–36 μ; filament 3.3–4.5 μ thick, coiled 5–8 times; conidiophore 15–20 × 2–4 μ.....*2. H. farinosum*
3. Conidia 20–30 × 37–56 μ; filament 4.5–6.5 μ, coiled 5–16 times..*3. H. sessile*
4. Conidiophores simple or little-branched.....5
4. Conidiophores much-branched, anastomosing.....6
5. Conidia golden-yellow, 19.5–27 × 36–45 μ.....*4. H. auratum*
5. Conidia hyaline to dilute fuscous, 20–25 × 22.5–33 μ.....*5. H. fuscosporum*
6. Conidia 18–27 × 28–45 μ, the filament 4.5–5.4 μ.....*6. H. ellipticum*
6 Conidia 16.2–18 × 18–24 μ, the filament 2.3–3.6 μ.....*7. H. reticulatum*

1. Helicoon Richonis (Boudier) Linder, n. comb.

Helicosporium Richonis Boudier, Icon. Myc. **4**: 349. *pl. 599*. 1905–10.

Small species, blackening by its extent the wood on which it grows. Sterile hyphae repent, septate, blackish, giving rise to short concolorous filaments, also septate, bearing a large conidium irregularly oval or rounded, formed of a brown filament,

multiseptate, 50–60 × 50–80 μ, 8–10-seriate. The height of the conidiophore does not exceed 1–1.5 μ.

On dead branches of *Populus*. Department of the Marne, *Richon*.

Fig. 14. *H. Richonis*. After Boudier.

The above description is adapted from the original and the figure is after the colored original illustration.

The species is quite distinctive in its color and size, and in the morphology of the conidiophore.

2. **Helicoon farinosum** Linder, n. sp.

Plate 26, figs. 1–2.

Colonies inconspicuous, white, powdery. Conidiophores hyaline, inconspicuous, 15–20 × 2–4 μ, tapering upwards. Conidia acrogenous, hyaline, the filament 3.5–4.5 μ thick, coiled 5–8 times in 3 planes to form a subglobose to ellipsoidal spore body, 23.4–36 × 25–27 μ.

On decaying wood. Massachusetts.

This species very strongly resembles *Helicoon sessile*, yet differs

in the smaller size of the spore, and by the fact that the cytoplasmic content is less dense and the septa more conspicuous.

Specimen examined:

United States:

Massachusetts: Cambridge, Fresh Pond, Oct. 11, 1892, *Thaxter*, TYPE (F).

3. **Helicoon sessile** Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 50. *fig. 17*. 1892.

Helicoon Fairmani Saccardo, Ann. Myc. **4**: 278. 1906.

Plate 26, figs. 12–16.

Colonies pulverulent, inconspicuous, white to pinkish, sparsely covering the substratum. The conidiophores in culture seldom exceeding 50 μ in length, apparently obsolete on the natural substratum. Conidia acrogenous, borne singly, hyaline to pinkish, the filament (4)–4.5–6.5 μ thick, coiled 5–16 times in 3 planes to form an ellipsoidal body, 20–30 × 37–59 μ.

On very moist well-decayed wood of deciduous trees. Eastern United States.

The type of this species appears to be material collected by Ellis, presumably in New Jersey, and sent to Morgan under the herbarium name of *Helicosporium conchoides*, a fragment of which specimen was communicated by Morgan to Dr. Thaxter. *Helicoon Fairmani*, collected in New York by C. E. Fairman and sent to Saccardo who described the species as new, differs in no respect from Morgan's.

Specimens examined:

United States:

Massachusetts: Canton, on decaying maple wood, *Linder, 241*, and July 16, 1925, *Linder* (L, F); Sharon, Nov. 1922, *Piguet* (L 252); Waverley, Oct. 2, 1892, and Oct. 4, 1892, *Thaxter* (F).

New Jersey: *Ellis*, comm. to R. Thaxter by Morgan, CO-TYPE (F).

4. **Helicoon auratum** (Ellis) Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 50. *fig. 18*. 1892.

Helicosporium auratum Ellis, Torr. Bot. Club Bull. **6**: 106. 1876.

Plate 26, figs. 3–5.

Colony golden-yellow, effuse, pulverulent. Conidiophores erect, simple or rarely sparingly branched, fuscous below, subhyaline at terminal cells, 32–150 × 3.6–5.4 μ. Spores hygroscopic, borne singly or in clusters, never in chains, acro-pleurogenously on upper subhyaline part of the conidiophores, hyaline to light yellow, the filament 2.5–3.6 μ, coiling in 3 planes to form an ovoid to elongate-elliptical spore body, 8–16-seriate, 36–45 × 19.5–27 μ.

Growing on partly buried and well-decayed wood in moist places. April to November. Eastern United States.

Helicoon auratum is a thoroughly characteristic species differing from all other members of the genus by the brilliant yellow color of the spores, and the characteristic dark erect conidiophores.

Specimens examined:

Exsiccati: Ellis, N. Am. Fungi, 551, TYPE; Reliquiae Farlow., 175, as *Helicosporium aureum.*

United States:

Massachusetts: Billerica, *Piper* (F); Brookline, Hammond's Pond, *Faull* (F); Canton, *Linder, 179, 221, 1018* (F, L, MBG); Sharon, *Piguet* (L 237).

5. Helicoon fuscosporum Linder, n. sp.

Plate 26, figs. 6–8.

Colony inconspicuous, sparse, of scattered conidiophores visible only under a hand lens. Conidiophores erect, simple or very sparingly branched above, septate, fuscous below, subhyaline to dilute fuscous above, 70–200 × 4.5–5 μ, slightly tapering upwards to 3 μ, somewhat constricted at the septa. Conidia acrogenous, borne singly, occasionally in pairs, light fuscous, the filament 2.7–3 μ thick, coiling in 3 planes to form 6–9-seriate, subovate to ellipsoidal spore bodies, 20–25 × 22.5–33 μ.

Growing on catkins of *Alnus* sp. Connecticut.

Specimen examined:

United States:

Connecticut: New Haven, May, 1901, *R. Thaxter*, TYPE (F).

6. Helicoon ellipticum (Peck) Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 50. *fig. 19.* 1892.

Helicosporium ellipticum Peck, N. Y. State Mus. Rept. **27**: 103. *pl. 2, fig. 9–12.* 1877.

Helicoryne ramosa Berkeley & Smith, in Berkeley, Gard. Chron. N. S. **17**: 463. *fig. 73.* 1882.

Helicosporium ramosum (B. & S.) Massee, Brit. Fung. Fl. **3**: 440. *pl. p. 442, fig. 29.* 1893.

Plate 26, fig. 11; plate 31, fig. 5.

Colony loose, cottony, separable from the substratum, "Brownish Olive." Conidiophores elongate, much branched and anastomosing, up to 800 μ long, 4.5–5.5 μ thick. Spores borne singly on lateral hyaline teeth on the lower two-thirds of the conidiophores or nearer the tips in more mature specimens, "Honey Color" to "Olive Ochre" in mass, the filament 4.5–5.4 μ thick, coiled in 3 planes to form 7–10-seriate, elongate-ellipsoidal or ellipsoidal spore bodies, 18–27 × 28–45 μ.

On decaying coniferous wood in moist shaded places. Spring to fall. Eastern United States.

Specimens examined:

Exsiccati: Ellis, N. Am. Fungi, 124; C. E. Fairman, Mycotheca Fairmani, 1191.

United States:

Maine: Kittery Point, Sept. 26, 1892, with *Helicosporium aureum*, June 30, 1892, Aug. 1892, *R. Thaxter* (F); York, July 9, 1892, *R. Thaxter* (F).

New Hampshire: Intervale, July, 1901, *R. Thaxter* (F).

Massachusetts: Pepperell, Oct. 1926, *C. W. Dodge* (F, MBG, 66537); Waverley, Oct. 1892, *R. Thaxter* (F).

Connecticut: Milford, *R. Thaxter* (F).

New York: in Berkeley Herb., type of *Helicosporium ramosum* (K); Lyndonville, Sept. 1900, *C. E. Fairman*, in Mycotheca Fairmani.

New Jersey: Vineland, *J. B. Ellis*, in N. Am. Fungi, TYPE.

7. Helicoon reticulatum Linder, n. sp.

Plate 26, figs. 9–10.

Colony loose, cottony, separable from the substratum, "Raw Umber" to "Brownish Olive." Conidiophores dilute fuscous to

fuscous, erect, frequently branched and anastomosing to form a complicated network of hyphae up to 800 μ long, 3.6–5.4 μ thick. Spores produced singly and pleurogenously on the lower two-thirds of the conidiophore, on hyaline teeth, the spore filament dilute ochraceous, the first coil often hyaline, 2.6–3.6 μ thick, coiled in 3 planes to form 6–8-seriate, ovoid to ovoid-elliptical spore bodies, 16–18 × 18–24 μ.

On moist decaying wood, generally coniferous. Summer. Maine south and west to Mississippi.

This species closely resembles *Helicoon ellipticum* in the appearance of the colonies and of the conidiophores. The smaller spores, however, separate it from that species. The range is apparently more southern.

Specimens examined:

United States:

Maine: Kittery Point, Sept. 26, 1892, *Thaxter* (F).

Massachusetts: Canton, *Linder, 1010* (L, F).

Connecticut: New Haven, July, 1889, *R. Thaxter* (F).

Alabama: Montgomery, *R. P. Burke, 373* (MBG 57241).

Mississippi: Starkville, Apr. 3, 1889, *G. W. Merrill*, TYPE (F).

SPECIES IMPERFECTLY KNOWN

Helicoon politulum (Schulzer) Lindau in Rabenhorst's Kryptog. Fl. Deutschl., Öst. u. d. Schweiz **1**[9]: 277. 1908.

Helicosporium politulum Schulzer, Flora **60**: 271. 1877.

"Räschen schwarzgrau, höchst unscheinbar, mehrere mm. breit. Mycel kriechend, septiert, verzweigt, kaum durchscheinend. Konidienträger gesellig, unverzweigt, aufrecht oder gekrümmt, weitläufig septiert, bisweilen an den Wänden etwas eingeschnürt, bis oben hin gleich dick, schwarzbraun, durchscheinend. Konidien am Ende der Träger zu einer köpfchenartigen Masse zusammengewunden, die in Wasser sich trennt, korkzieherartig oder sprungfederartig gewunden von rechts nach links, dicht septiert, schwarzgrau, durchscheinend.

"Auf feuchten modernden Weidenastspänen bei Vinkovce in Slavonien (Schulzer)."

The above description is Lindau's condensation and interpretation of Schulzer's original description. This species apparently

is not unlike *Helicoon Richonis*. Its identity, however, must remain obscure until spore measurements are available.

HELICODENDRON

Helicodendron Peyronel, Nuovo Giorn. Bot. Ital. N. S. **25**: 460. *figs. 71–76.* 1918.

Helicodesmus Linder, Am. Jour. Bot. **12**: 259–269. *pl. 23–24.* 1925.

Type species of the genus is *Helicodendron paradoxum.*

Conidiophores much-branched to simple or apparently obsolete, hyaline or fuscous. Conidia in chains, coiled in 3 planes to form a cylindrical, ovoid, or ellipsoid spore body, occasionally only few-seriate, then forming an almost disc-shaped body, hyaline, colored, or fuscous.

The most important distinguishing character of this genus is the method of producing spores in chains. The ovoid or elliptical shape of the coiled spore is, in general, fairly constant, although the spores of *Helicodendron paradoxum* and *H. triglitziensis* more closely resemble in shape the spores of species of *Helicoma.*

KEY TO THE SPECIES OF HELICODENDRON

1. Conidia less than 4-seriate; the conidial filament 4 μ or more in diameter....2
1. Conidia more than 4-seriate, if less, then the conidial filament less than 3 μ in diameter....3
2. Conidia 1–5-septate, at first hyaline, then becoming light green. *1. H. paradoxum*
2. Conidia 6–8-, rarely 3–10-, septate, always hyaline. *2. H. triglitziensis*
3. Conidia 18–22 × 20–32 μ, the filaments 2.5–3.6 μ in diameter. *3. H. tubulosum*
3. Conidia smaller....4
4. Conidia 10.8–14.4 × 14.4–27 μ; the filament 1.5–2.5 μ thick, subhyaline to subfuscous. *4. H. fuscum*
4. Conidia 8–10 × 11 μ; the filament 1.2–1.8 μ thick, hyaline. *5. H. hyalinum*

1. Helicodendron paradoxum Peyronel, Nuovo Giorn. Bot. Ital. N. S. **25**: 460. *fig. 71–76.* 1918.

Clusters broadly effuse, pulverulent, at first white, then light and intense green, finally sordid. Sterile mycelium repent, sparsely branched, septate, hyaline, 4–6 μ thick. Conidiophores erect, branching, septate, slightly constricted at the septa, 70–100 × 5–7μ. Conidia coiled 1–3½, mostly 1½–2, times, 1–3-septate, slightly constricted at the septa, the distal end obtuse, at first hyaline to light green, becoming darker with age, prolif-

erating to produce branched chains, the conidial filament 5.5–6.5 μ thick; the coiled conidia 35–40–60 μ in diameter.

Fig. 15. *H. paradoxum*. After Peyronel.

On decorticated trunks and branches at the edge of mountain streams, frequent; on *Alnus viridus* (Li Cumbal di l'Truncea, 1400 m. alt.), Aug. 1914; on *Cytisis laburnis* (Li Cumbal da Sere, 1070 m. alt.), Apr. 1916, Riclaretto in the Piedmont Valley, North Italy.

2. Helicodendron triglitziensis (Jaap) Linder, n. comb.

Helicomyces triglitziensis Jaap, Verhandl. Bot. Ver. Prov. Brandenb. **58**: 43. 1916.

Helicodesmus albus Linder, Am. Jour. Bot. **12**: 259–269. *pl. 23–24*. 1925.

Plate 27, figs. 1–2; plate 30, fig. 4.

Colonies as white flocculent tufts on the substratum. Vegetative hyphae hyaline, septate, and much-branched. Conidiophores arising singly as short hyaline, mostly simple aerial branches bearing conidia acropleurogenously. Conidia in branching chains, hyaline, 1¾–2¾-times convolute, 6–8-, seldom 3–10-, septate, smooth, slightly constricted at the septa; the filament rounded-tapering at the basal end, the distal end bluntly rounded, 3.6–6.2 μ thick; the coiled conidia 16.2–25.4 μ in diameter.

Specimens examined:

Exsiccati: Jaap, O., Fungi Select. Exsicc., 847.

Germany: Triglitz, *Jaap*, in Fungi Select. Exsicc., TYPE.

United States:

Massachusetts: Fresh Pond, Cambridge, *W. H. Weston*, type of *Helicodesmus albus* (F); Fresh Pond, *Linder, 291* (L).

3. Helicodendron tubulosum (Reiss) Linder, n. comb.

Helicomyces tubulosus Reiss, Beitr. Pilzk. **11**: 140. *pl. 3, fig. 11–13*. 1853.

Helicoon tubulosum (Reiss) Saccardo, Syll. Fung. **11**: 609. 1895.

Plate 27, figs. 7–11.

Colonies as shining white, scattered, minute granular tufts of spores on the surface of the substratum. Conidiophores inconspicuous, 0–50–100 × 3.5–5 μ. Conidia acrogenous, in branching chains, 4–12-times coiled to form cylindrical to ellipsoidal bodies, 18–22 × 20–32 μ, the filaments 2.5–3.6 μ thick.

On decaying *Salix* twigs and bark in moist places. Europe and America.

As illustrated by Cooke,[1] the conidium is coiled to form a rounded cone-shaped body, the filaments of which are deeply constricted at the septa, thus giving it a toruloid appearance. When the writer examined the specimen, deposited in the Kew Herbarium, there were no spores. It seems probable, however, that the figure as shown was drawn from spores in a plasmolyzed condition.

Helicodendron tubulosum appears to be a stage in the complicated life history of *Clathrosphaera spirifera* described by Zalewski,[2] a life-history divided into four phases represented by as many spore forms. Through the kindness of Professor Wiener of Harvard, the writer was enabled to obtain a full translation of this paper, and from a study of this to draw the following conclusions. In the first place, the four spore forms,—the clathroid spores, the helical spores, a sclerotium-like stage for which he adopts the name "spore complex," and a clustered oidium-like type of fructification,—occurred from early spring to late fall in the sequence given. Zalewski complained of the frequent contaminations of his cultures by *Penicillium*, and even though he noticed the resemblance of his "spore complexes" to the sclerotia that so frequently are produced by that ubiquitous fungus, he seemed willing to concede such a stage to his new genus without attempting to isolate it and carry it through its life history in pure culture. Also, the connections between the other phases were not ascertained by direct observation. During a study of

[1] Cooke, M. C. Grevillea **3**: 178. *pl. 48, fig. 3.* 1875.

[2] Zalewski, A. Rozpraw Spraw. Wydz. matem.-przyr. Akad. Krakau **18**: 153–191. *7 pl.* 1888.

the cultures extending over many months, although two stages were found in the same culture, in no case did Zalewski find one stage actually giving rise to another, thus justifying the conclusion that other fungi in a dormant state were present. Yet because of the resemblance between the content of the spiral and the clathroid spores, because of the similarity between the hyphae of germination of the two forms, it was thought to be a single life history of which these forms were different stages. The only culture that Zalewski carried through a complete cycle of spore forms was a gross culture. This gives added significance to his statement that many cultures kept under the same conditions gave rise to different combinations of spore forms. In any event there must remain some uncertainty as to the true life-cycle of *Clathrosphaera* until it is again collected and the life history studied in pure culture.

Specimens examined:

England: Hereford, *J. G. Morris* (no spores) (K).

Austria: Wienerwald, *von Höhnel* (F).

United States:

Massachusetts: Cambridge, on *Salix* twigs, *Linder* (slide F, L); Arlington, *Martin* (F).

4. **Helicodendron fuscum** (B. & C.) Linder, n. comb.

Helicosporium fuscum Berkeley & Curtis, in Berkeley, Grevillea **3**: 51. 1874.

Helicosporium thysanophorum Ellis & Harkness, Torr. Bot. Club Bull. **8**: 27. 1881.

Helicoon thysanophorum (E. & H.) Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 49. *fig. 16*. 1892.

Plate 27, figs. 5–6.

Colony inconspicuous, densely cespitose or sometimes effuse, "Mummy Brown to "Sepia," under the hand lens "Saccardo's Umber" from masses of spores. Conidiophores very short, erect. Spores subhyaline to dilute brownish, consisting of filaments 1.5–2.5 μ thick, coiled in 3 planes to form 5–12-seriate, cylindrical bodies, 14.4–27 × 10.8–14.4 μ. The spores proliferate to form branching chains.

Specimens examined:
Exsiccati: Ellis, N. Am. Fungi, 552.
United States:
New Jersey: Newfield, *J. B. Ellis*, type of *Helicosporium thysanophorum*, in Ellis, N. Am. Fungi.
South Carolina: *Curtis*, TYPE (K, slide F).

5. Helicodendron hyalinum Linder, n. sp.

Plate 27, figs. 3–4.

Colonies white, scattered, minute, the dried material visible only under the low power of the microscope. Conidiophores hyaline, ascending, sparsely branched, 15–40 × 1.3–2 μ. Conidia hyaline, the filament 1.2–1.75 μ thick, coiled in 3 planes to form short, 2–5-seriate, cylindrical spore bodies 11 × 8–10 μ.

On decaying wood.

This species, on account of the few-seriate, small, hyaline spores, is quite distinct from any species heretofore described.

Specimens examined:
United States:
Massachusetts: Waverley, on decaying wood, Oct. 12, 1899, *R. Thaxter*, TYPE (F); under wet boards, Oct. 1, 1892, *R. Thaxter* (F); South Billerica, *Clinton* (F).

HELICOSTILBE

Helicostilbe von Höhnel, emended.

Helicostilbe von Höhnel, Kön. Akad. Wiss. Wien, math.-nat. Kl. Sitzungsber. **111**: 1028–1029. 1902.

The type species is *Helicostilbe simplex*.

Conidiophores aggregated to form a stele. The conidia acrogenous, in terminal clusters, not produced on scandent or repent mycelium, non-hygroscopic, similar to those of *Helicoma*.

Thus emended, *Helicostilbe helicinum* is excluded from this genus and transferred to *Helicomyces*, as explained in the discussion under *Helicomyces scandens*. The genus is represented by a single species.

1. **Helicostilbe simplex** Petch, Roy. Bot. Gard. Peradeniya, Ann. 7: 321. 1922.

Plate 28, figs. 10–12.

Synnemata scattered, up to 0.8 mm. high and 30 μ in diameter, black, equal, slightly spreading at the base, each arising from a small attachment disc of coalescent hyphae, the stalk glabrous, at least in small specimens, the hyphal elements fuscous, terminating in slightly swollen club-shaped apices which may be simple or branched, erect or recurved. The conidia acrogenous, solitary, fuliginous, 1–1¼-times coiled, 3–4-septate, the septa subhyaline, bordered on either side by narrow dark bands, the filaments 4 μ thick, slightly tapering or bluntly rounded at the basal end, bluntly rounded at the distal end; diameter of coiled conidia 8–10 μ.

On the under surface of living leaves of *Daphniphyllum glaucescens*. Ceylon.

In his original description, Petch states that the stalks are villous, with short hyphal tips but in the type material, kindly loaned to the writer by the Curator of the Herbarium of the Royal Botanic Garden in Peradeniya, the stalks were entirely glabrous except for a short distance below the apices. It is possible that the villous appearance is due to fallen spores that have adhered to the stalks. The measurements of the synnemata are those given by Petch.

Specimen examined:

Ceylon: Hakgala, April, 1917, *Petch*, TYPE (Pe 6263, K, and slide F, MBG).

TROPOSPORELLA

Troposporella Karsten, Hedwigia **31**: 299. 1892.

The type and only species is *Troposporella fumosa*.

Sporodochia pulvinate to subspherical, the surface dry, granular, fuliginous to olivaceous. The conidiophores are somewhat branched, closely aggregated, strongly constricted at the septa, light fuscous. Conidia as in *Helicoma*.

This genus appears to be intermediate between species of *Helicoma*, represented by *H. monilipes* and *H. olivaceum*, and *Everhartia*. It differs from the former in that the conidiophores

are very closely aggregated to form a definite and compact subglobose fruiting body; from the latter by the fact that the fruiting body is apparently less highly developed and lacks the gelatinous secretions which make the fruiting bodies of *Everhartia* hard and corneous when dry.

1. **Troposporella fumosa** Karsten, *l.c.*

Plate 29, figs. 10–14.

Sporodochia scattered, pulvinate to subspherical, the surface granular, "Snuff Brown," 200–350 μ in diameter. Conidiophores densely aggregate, sparsely branched, deeply constricted at the septa so as to give a monilioid appearance, dilute to light fuscous, 50–90 × 3–5 μ, the terminal cells when sterile frequently globose and reaching 7 μ in diameter. Conidia dilute to light fuscous, 9–13-septate, the filament closely coiled 1½–2 times, 4–4.5 μ thick, tapering to the truncate basal end, abruptly rounded at the distal end; diameter of coiled conidia 12–16 μ.

On old bark of *Populus* sp. Finland.

The type material of this species was kindly loaned for examination by Dr. Harold Lindberg, to whom the writer wishes to express his deep appreciation.

Specimen examined:

Finland: Mustiala, *Karsten*, TYPE (H, slide F, MBG).

EVERHARTIA

Everhartia Saccardo & Ellis, in Saccardo, Michelia **2**: 580. 1880; Saccardo, Syll. Fung. **4**: 729. 1888; Thaxter, Bot. Gaz. **16**: 204–205. *pl. 20, fig. 10–12.* 1891.

The type species of the genus is *Everhartia hymenuloides*.

Sporodochia verruciform, stipitate to substipitate, superficial, scattered, small. Conidia hyaline or light-colored, surrounded by mucus, flat, tightly coiled 1–2½ times, the filament 3– many-septate, non-hygroscopic.

Everhartia, so far as is known from collections, appears to be confined to temperate North America. The distribution, in the light of present-day knowledge, serves somewhat to delimit the genus. There are, however, other characters which definitely

separate this genus from the tropical *Delortia* into which von Höhnel transferred *E. lignitalis*. In the first place, the fruiting bodies of *Everhartia* do not appear to be as large or as gelatinous as those of *Delortia*. On drying, the species of *Everhartia* become corneous, and, although shrinking, apparently retain somewhat of their original shape. The other genus, although often as much as one centimeter in diameter, dries down until nothing remains but a flat, somewhat glazed layer on the substratum. This behavior is due to the fact that relatively few sterile threads, much exceeding the length of the conidiophores, secrete a copious supply of mucilaginous material in which the spores are imbedded. In *Everhartia* the conidiophores, while having a mucilaginous sheath, are much more numerous and aggregate to form a definite sporodochial body of almost parallel threads which maintain the shape of the fruiting body after it is dry. In addition, the spores are definitely produced on the outside of the fructification. Such conspicuous differences in the fruiting body alone are sufficient to separate the two genera.

KEY TO THE SPECIES OF EVERHARTIA

1. Conidia 3-septate ..... *1. E. lignitalis*
1. Conidia more than 3-septate 2
2. Conidia 4–8-septate ..... *2. E. candida*
2. Conidia more than 8-septate ..... *3. E hymenuloides*

1. Everhartia lignitalis Thaxter, Bot. Gaz. **16**: 204–205. *pl. 20, fig. 10–12.* 1891.

Delortia lignitalis (Thaxt.) von Höhnel, Kön. Akad. Wiss. Wien, math.-nat. Kl. Sitzungsber. **125**: 89–90. 1916.

Plate 29, figs. 1–4.

Sporodochia scattered, superficial, stipitate or substipitate, yellowish, becoming blackish towards the base, subcylindrical or expanding upwards, 250–400 × 100–150 μ. Spores hyaline, terminal, 3-septate, *the filament* 3.5–4 μ in diameter, the rounded base and snout-like apex approaching one another in a single convolution 12–13 (*8–10*) × 7–9 μ; extruded in a yellow viscous rounded mass. Sporiferous hyphae septate, subdichotomously branched, mingled with longer, usually simple, sterile hyphae.

The above is the original description with the writer's modifications in italics.

On wet decaying wood. Eastern United States.

Specimens examined:

United States:

Connecticut: West Haven, on wet logs, *Thaxter*, TYPE (F).

Tennessee: Burbank, Aug. 1896, *Thaxter* (F).

2. Everhartia candida Thaxter in herb. n. sp.

Plate 29, figs. 5–7.

Sporodochia scattered, superficial, irregularly hemispherical or elongate, 0.5–1 × 0.5–2 mm., white, when dry yellowish and horny. Conidia hyaline, disc-shaped, coiled 1½–1¾ times, 4–7-septate, imbedded in mucus; the conidial filament 3–3.5 μ thick, bluntly rounded at the distal end, tapering to a narrow truncate basal end; the coiled conidia 9–12 μ in diameter. Sterile hyphae hyaline, slender, mostly confined to the periphery of the sporogenous area.

On decaying wood. Eastern United States.

Specimens examined:

United States:

Maine: York, Aug. 14, 1897, Sept. 22, 1892, *Thaxter* (F); Kittery Point, Aug. 30, 1890, *Thaxter*, TYPE (F).

New Hampshire: Intervale, Sept. 1901, *Thaxter* (F).

Maryland: Corunna, July, 1891, *Thaxter* (F).

3. Everhartia hymenuloides Saccardo & Ellis, in Saccardo, Michelia **2**: 580. 1880.

Plate 29, figs. 8–9.

Sporodochia sessile, irregular in shape, dark fuscous, scattered, small, horny when dry. Conidia hyaline or dilute colored, coiled 2–2½ times, 16–25-septate, imbedded in a yellow-olive mucus; the conidial filament 2.5–3.5 μ thick, abruptly rounded at both ends; diameter of coiled conidia 13–18–(20) μ.

On *Sorghum nutans*. New Jersey.

Von Höhnel mentions finding microconidia in old colonies. These he states measure 3 × 1.6 μ, and are found in the slime.

He also questions the status of the species, stating that because of its gelatinous texture and the greenish slime, it should be considered an alga.

Specimens examined:

Exsiccati: Ellis, N. Am. Fungi, 969.

United States:

New Jersey: Newfield, *Ellis, 3582*, TYPE, in Ellis, N. Am. Fungi.

DELORTIA

Delortia Patouillard, in Patouillard & Gaillard, Soc. Myc. Fr. Bull. **4**: 43–44. *pl. 13, fig. 5 a–f.* 1888; Saccardo, Syll. Fung. **6**: 795. 1888.

The type species of the genus is *Delortia palmicola.*

Sporodochia tuberculiform, gelatinous, white. Spores 1–3-septate, hyaline, coiled in 2 planes, non-hygroscopic. The conidiophores slender, hyaline, septate, abruptly swollen below the conidia. Sterile hyphae exceeding the conidiophores, long, slender, flexuous, secreting a copious supply of mucilaginous material which serves as a matrix. One species.

1. **Delortia palmicola** Patouillard, *l.c.*

Plate 29, figs. 19–23.

Sporodochia tuberculiform, milky-gelatinous, up to 1 cm. in diameter, composed of hyaline, septate, branched mycelium; the vegetative parts and conidia imbedded in a gelatinous matrix. Conidiophores slender, 1.2–2.5 μ in diameter, sparsely branched, swollen at the apex to form an apophysis-like structure 3–3.5 μ thick. Conidia hyaline, 2–4-septate, the filament once-coiled to form horse-shoe-shaped body 17.5–21–(25) μ diam.; the filament 13–14 μ thick, abruptly rounded at the distal end, bluntly tapering-rounded at the basal end.

On decaying parts of palms, more rarely on other decaying wood. Tropical America, Liberia.

Although considered to belong to the Tremellaceae by Patouillard, there is little evidence for so classifying this species unless the gelatinous character is given undue importance. From

an examination of material preserved in formaldehyde, swollen in lacto-phenol, and then stained with Delafield's hematoxylin, it is clear that nuclear behavior does not substantiate such a position. The nucleus in the terminal cell of the conidiophore enlarges and then divides, one daughter nucleus migrating to the conidium initial, the other remaining in the now-swollen cell of the conidiophore where it apparently disintegrates with the remainder of the cell content when the conidium reaches maturity (pl. 29, fig. 19 a–d). In the conidium, the nucleus migrates to the center of the cell and there divides, following which the first septum is laid down. The further history and behavior of the nucleus was impossible to learn because of the improperly killed material. It is clear, however, that the intervals in laying down the septa are very irregular, and that the procedure does not follow that of the Auriculariales, to say nothing of the Tremellales.

Specimens examined:

Grenada: *Thaxter* (F).

Venezuela: Atures, *Gaillard*, TYPE (F).

British Guiana: Bartica, *Linder, 722;* Koreai Creek, Essequibo River, on decaying *Cecropia* wood, *Linder, 721;* Plantation Vryheid, Demerara River, *Linder, 920* (F).

Liberia: Firestone Plantation No. 3, Du River, *Linder* (F).

HOBSONIA

Hobsonia Berkeley, in Massee, Ann. Bot. **5**: 509. *1 fig.* 1891; Saccardo, Syll. Fung. **11**: 653. 1895.

The type species is *Hobsonia gigaspora.*

Sporodochia verruciform, gelatinous or dry and granular on the surface. Conidia of long stout filaments, multiseptate, coiled in 3 planes or irregularly to form tangled knots, often proliferating.

This species appears to be closely allied to *Delortia.* The spores of the genus, however, are irregularly coiled, multiseptate, and often proliferating, while those of *Delortia* are constantly flat, few-septate, and never proliferate. These characters are sufficiently distinct to warrant the separation of the two genera. *Hobsonia* is represented by two species.

1. **Hobsonia gigaspora** Berkeley, *l.c.*
Hobsonia Ackermanni Patouillard, Soc. Myc. Fr. Bull. **18**: 185. *1 fig.* 1902.

Plate 28, figs. 6–9.

Sporodochia milky-white, gelatinous when fresh, "Cinnamon Buff" and horny in the dried state. The conidiophores hyaline, branched, slender, 1.8–3 μ thick, imbedded in the gelatinous matrix. Conidia spirally or irregularly coiled, at maturity forming tangled knots, the filament hyaline, multiseptate, (6)–8–12–(14) μ thick, often proliferating.

On dead wood. West Indies and northern South America.

Patouillard, in describing his species, states that it differs conspicuously from *H. gigaspora* by the dimensions of the receptacle and the form of the spore. The spores of *H. Ackermanni* as shown in the figure are equally as typical of *H. gigaspora*, and the sizes obtained from type material intergrade so that it is impossible to separate the two species on this character. The receptacle, or apex of the conidiophore, upon which Patouillard laid so much stress is found to be the same as that in typical *H. gigaspora*. Other diagnostic characters for separating these two species are lacking.

Specimens examined:

Dominica: *W. R. Elliott, 379, 452, 1441*, as *Helicomyces mirabilis* (BM); ex herb. Massee (NY).
Guadeloupe: *Ackermann*, type of *H. Ackermanni* (F).
Grenada: Grand Etang, *Thaxter* (F).
Trinidad: Aripo Savannah, *Thaxter* (F).
Venezuela: (F, K) TYPE.

2. **Hobsonia mirabilis** (Peck) Linder, n. comb.
Helicomyces mirabilis Peck, N. Y. State Mus. Rept. **34**: 46. *fig. 6–10.* 1881.

Plate 28, figs. 1–5; pl. 31, fig. 1.

Colonies as white tufts or irregular patches, 200 μ or more in diameter, not gelatinous or if gelatinous not conspicuously so, drying to "Ochraceous Buff," the surface powdery or granular. Conidiophores hyaline, slender, 1.5–3 μ thick, branched, septate,

surrounded below by gelatinous sheaths, but not imbedded in a gelatinous matrix. Conidia at first spirally coiled to form a more or less conical spore body, later irregularly coiled to produce tangled knots, the filaments hyaline, multiseptate, (9)–12–15–(17) μ thick, proliferating.

On decaying plant remains. Eastern United States.

The type of this species was collected in Ithaca, New York, by Prentiss and sent to Peck who described this species, and it is probably in the herbarium of the New York State Museum, Albany, New York.

Hobsonia mirabilis differs from *H. gigaspora* in the non-gelatinous colonies, a character apparently not due to seasonal variations in humidity, since the latter species when collected in Trinidad during the dry season was even then gelatinous, according to Dr. Thaxter's field notes. There are also other characters that separate the two species. The conidiophores of *H. gigaspora* are subdichotomously branched, at least near the conidia, while those of this species appear to be less frequently branched; the conidiophores at the base of the conidia are spirally coiled in the younger stages of *H. gigaspora*, and not at all or only slightly so in this species. The conidia also show some slight differences, the width of the spore filaments as measured across the septa being greater in this species. This is shown in the accompanying graph (fig. 16) where the spores of the gelatinous species are represented by approximately an equal number of *H. gigaspora* and *H. Ackermanni*. It shows clearly the difference in the sizes of the gelatinous and non-gelatinous species. In addition the spores have a more turgid appearance and the protoplasmic content is denser.

Specimens examined:

United States:

New York: Ithaca, *Dudley* (F).

Tennessee: Burbank, on corn cob and stems of *Aristolochia* sp., Aug. 10, 1896, *Thaxter* (F).

DREPANOCONIS

Drepanoconis Schroeter & Hennings, Hedwigia **35**: 211. 1896; Saccardo, Syll. Fung. **14**: 457. 1899.

Clinoconidium Patouillard, Soc. Myc. Fr. Bull. **14**: 156. 1898.

The type species is *Drepanoconis larvaeformis*.

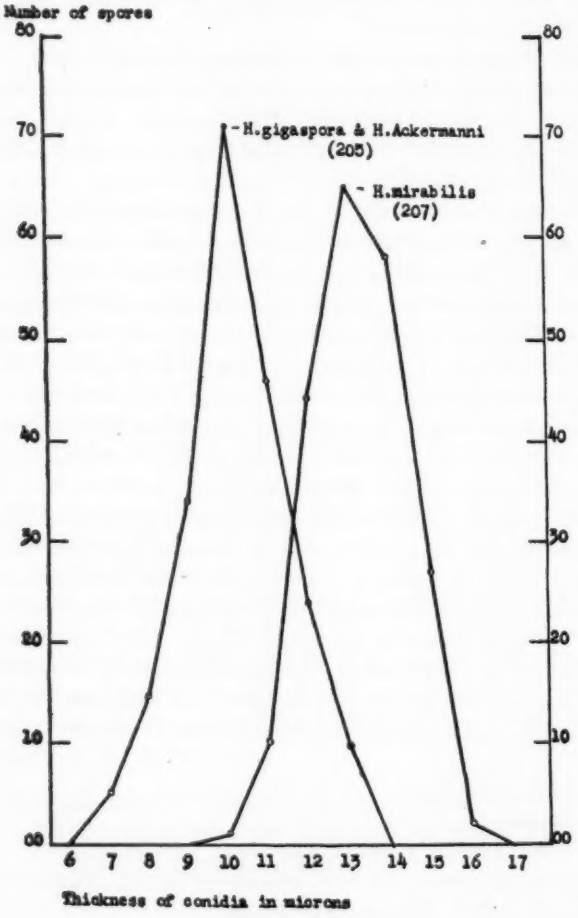

Fig. 16.

Sterile mycelium intercellular, forming a layer under the epidermis of the host, at first covered, then erumpent. The conidiophores hyaline, short, erect, simple, between the longer

and more slender, erect, flexuous, sterile hyphae. The conidia ¾–1½-times coiled, the filament thick, non-hygroscopic, the cell wall thick, often laminated in appearance, the cell content occupying approximately one-third the width of the filament.

The spores of this genus are thoroughly characteristic and serve to identify it even when the pseudostromatic nature of the mycelium is not clearly observed. The sterile hyphae are often crowded with the freed spores, under which condition they appear to be conidiophores, although a section of the material clearly demonstrates their sterility. The genus is represented by two species, both of which are probably parasitic.

1. **Drepanoconis larvaeformis** Spegazzini, Mus. Nac. Buenos Aires, Ann. **9**: 9. 1903.

Helicomyces larvaeformis Spegazzini, Fungi Guar. **1**: 158. 1883.

Drepanoconis brasiliense Schroeter & Hennings, in Hennings, Hedwigia **35**: 211. 1896.

Uredo farinosa Hennings, Hedwigia **36**: 216. 1897.

Clinoconidium farinosum (Henn.) Patouillard, Soc. Myc. Fr. Bull. **14**: 156. 1898.

Drepanoconis fructigena Rick, Ann. Myc. **3**: 17. 1905.

Marsonia fructigena Rick, not Bresadola, Broteria **5**: 53. *pl. 5, fig. 10.* 1906.

Plate 29, figs. 15–17.

Colonies when fresh are white, on drying become "Light Buff" to light "Ochraceous Orange," at first subcutaneous, then erumpent, producing a pulvinate thickening when growing on leaves. Sterile mycelium intercellular, forming a mat from which arise the sterile hyphae and the conidiophores. Sterile hyphae hyaline, flexuous, simple or sparingly branched, 1–1.5 × 162–235 μ, much exceeding the conidiophores. Conidiophores hyaline, simple or occasionally branched above, 2–3 × 30 μ. Conidia acrogenous, hyaline, ½–1-coiled, soon deciduous, 4–9-celled, the cells in a single row, 2.5–4.5 μ thick, surrounded by a thick, hyaline, lamellate wall, making the diameter of the filament 10–17 μ; the coiled spore 16–24 μ in diameter.

Growing on fruit and leaves of Lauraceae. South America.

This species, although described in the Uredinales and Peronosporales, has found its place among the Fungi Imperfecti where it is to be hoped that it will remain. It is quite distinct from the related species, *D. anguisporus*. The uniseriate arrangement of the cells, the irregular horse-shoe shape, and the smaller size characterize it. *Drepanoconis fructigena* was said by Rick to differ from the accepted species by its smaller spores. Measurements of a large series of spores from the type of that species clearly indicate that although the spores vary somewhat in size, they intergrade with, and are essentially the same as, those of *D. larvaeformis*.

Judging by the following quotation from Rick's account in 'Broteria' of *Marsonia fructigena*, the species is parasitic. He says, "Die befallenen Früchte schwellen stark an und bekommen eine rötliche gefelderte Oberhaut. Schliesslich wird letztere abgeworfen und es erscheint der weisse, mehlige Ueberzug."

Specimens examined:

Exsiccati: Balansa, Plant. Uruguay., 3758.

Brazil: Sao Leopoldo, on fruit of *Oreodaphnis, Rick, 42*, type of *D. fructigena* (F); on leaves of *Nectandra* (F).

Uruguay: Guarapi, on fruit of Lauraceae, *Balansa*, in Plant. Uruguay., TYPE.

2. **Drepanoconis anguisporus** (Pat. & Lagerh.) Linder, n. comb.
Helicomyces anguisporus Patouillard & Lagerheim, in Patouillard, Soc. Myc. Fr. Bull. 8: 137. *pl. 12, fig. 4.* 1892.

Plate 29, fig. 18.

Mycelium cespitose, innate, later erumpent, effuse, pulverulent, white. Sterile hyphae flexuous, 100–200 × 1.8–3 μ, free above, the apex often slightly inflated. Conidia subsessile, produced in great number, hyaline, horse-shoe shaped, flat or spirally twisted, 1–1½-times coiled, the distal end slightly tapering, bluntly rounded, the basal end bluntly tapering-rounded to a broad, truncate apiculus 2–2.5 μ in diameter, 5–13-times septate, the protoplasmic content of the spore uniseriate or irregularly 2-seriate, the filament 9–18 μ thick; the coiled spore 21–41.5 μ in diameter.

Growing on the fruit of Lauraceae. Ecuador.

Specimen examined:
Ecuador: Pallatanga, *Lagerheim*, TYPE (B, F).

TROPOSPORIUM

Troposporium Harkness, Cal. Acad. Sci. Bull. **1**: 39. 1884; Morgan, Cinci. Soc. Nat. Hist. Jour. **15**: 52. 1892.

The type species is *Troposporium album*.

"Sporodochium superficial, verruciform, farinaceous; hyphae long, slender, flexuous, branched, the spores borne at the apex of slender branchlets. Spores spirally coiled into an elongate ellipsoidal body. The spores are like those of *Helicoon*."

This genus is the only one in the Tubercularіaceae that has the spores coiled in 3 planes as in *Helicoon*. There is only one species, the type of which has been lost.

1. **Troposporium album** Harkness, *l.c.*

"Sporodochium white, verruciform, thick, often confluent; hyphae slender, flexuous, branched, hyaline, the spores borne at the ends of slender branchlets. Spores hyaline, oblong-ellipsoidal, composed of 3–7 spires, closely coiled; spore 40–45 × 18–22 mic.; the thread about 7 mic. in thickness, continuous.

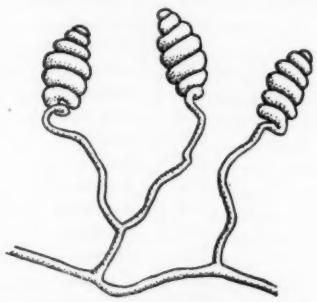

Fig. 17. *Troposporium album*. After Morgan.

"Growing on dead stems of *Corylus rostrata*. California. Harkness.

"The stroma consists of numerous granules and oil globules which are set free by breaking."

The above descriptions of the genus and species are taken from Morgan's monographic study of the North American Helicosporeae (*l.c.*).

Index to Species in Part II

New scientific names and combinations are printed in **bold face** type; synonyms in *italics*; and previously published names, in ordinary type.

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Explanation of Plate

PLATE 12

Fig. 1. *Helicomyces scandens* Morgan
A specimen in the intermediate stage of development, showing the loosely fasciculate, hyaline conidiophores clustered about the dark sterile setae. The transition from hyaline hyphae to the dark, pointed, sterile portions of the setae is clearly shown. × 500.

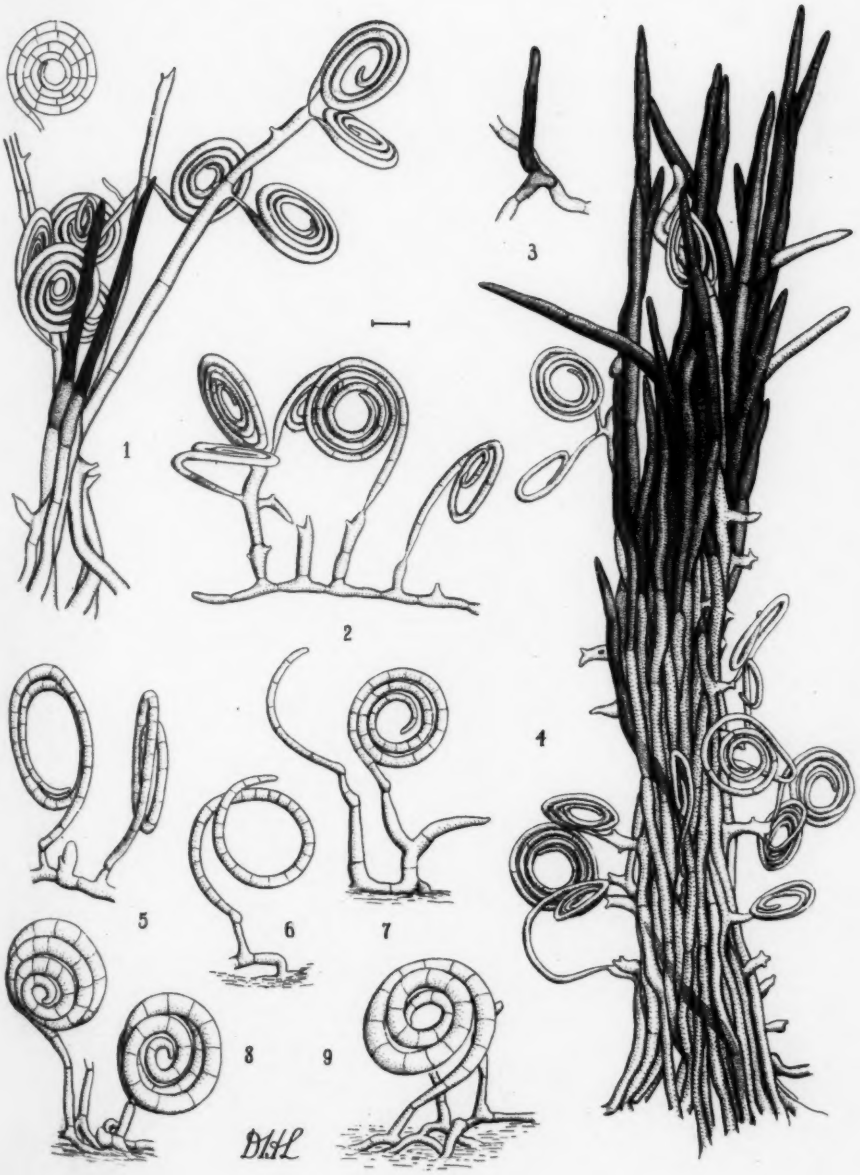
Fig. 2. *Helicomyces scandens* Morgan
An early stage of development of the fungus, previous to the formation of fascicles and the accompanying setae. × 500.

Fig. 3. *Helicomyces scandens* Morgan
A rudimentary seta produced in culture on potato dextrose agar. × 500.

Fig. 4. *Helicomyces scandens* Morgan
A fully mature specimen in which the sporogenous hyphae are fasciculate and the setae are numerous. × 500.

Figs. 5–7. *Helicomyces roseus* Lk.
The conidia are borne obliquely, either directly on the repent mycelium or else on short, ascending branches. × 500.

Figs. 8–9. *Helicomyces ambiguus* (Morgan) Linder
The stout conidia, coiled in 3 planes, are shown attached directly to the conidiophore, not obliquely as in *H. roseus*. Drawings made from type material. × 500.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Explanation of Plate

PLATE 13

Figs. 1–2. *Helicosporium vegetum* Nees

Young material that shows the simple erect conidiophore bearing the conidia on minute cylindrical teeth. Such young material has passed under the name of *H. olivaceum* Morgan. Fig. 2 is a drawing made from German material (*von Höhnel*, Wienerwald, June 9, 1907). × 500.

Fig. 3. *Helicosporium vegetum* Nees

A mature specimen in which the spores, in addition to being produced on the erect conidiophores, are also borne on a simple, elongate, subhyaline, lateral branch. Drawing from Missouri material (*Linder*, Gray Summit, MBG 66538). × 500.

Fig. 4. *Helicosporium gracile* (Morgan) Linder

A portion of a scandent, pellucid, fertile hypha that has given rise to simple conidiophores. Drawing from Iowa material (*G. W. Martin*). × 500.

Fig. 5. *Helicosporium guianensis* Linder

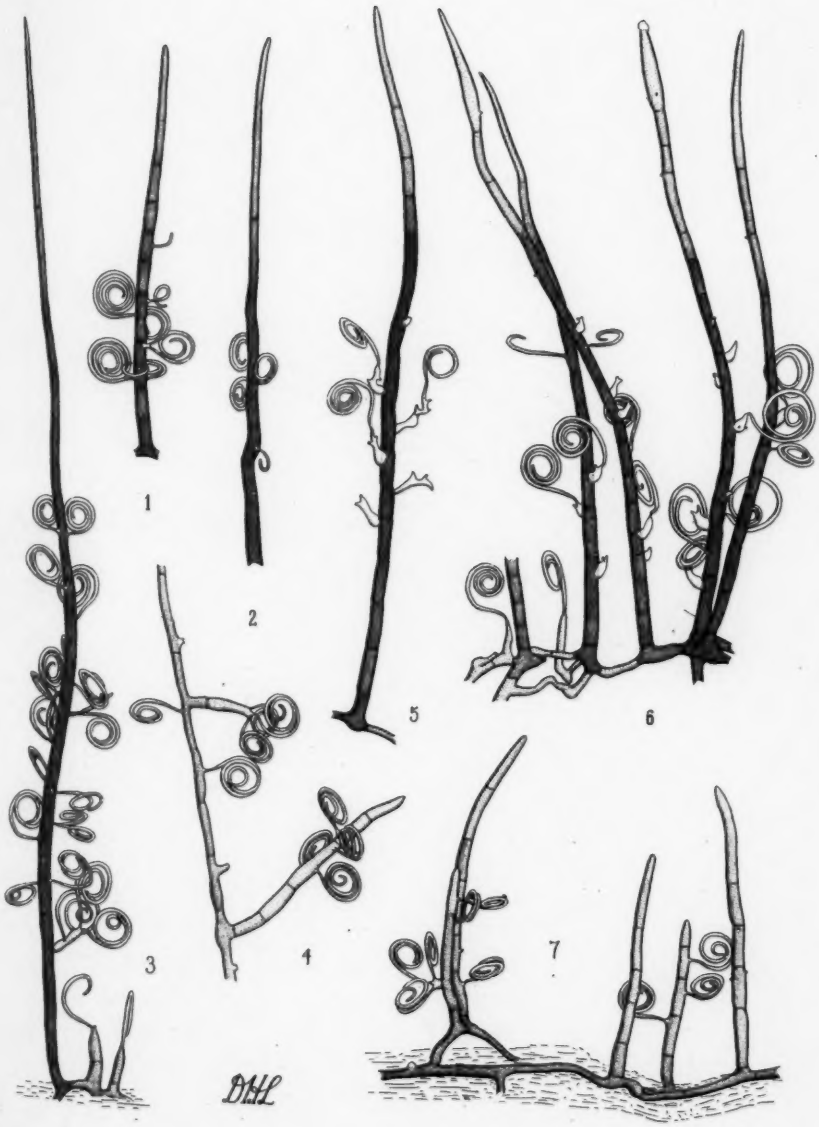
A mature specimen that shows the characteristically branched, bladder-like sporogenous projections. Drawing from type material. × 500.

Fig. 6. *Helicosporium guianensis* Linder

Less-mature specimens in which the bladder-like projections are simple. The terminal cells of the conidiophores are occasionally slightly inflated. Drawing from type material. × 500.

Fig. 7. *Helicosporium gracile* (Morgan) Linder

Erect conidiophores that have arisen from repent sterile mycelium. × 500.



LINDER—HELICOSPOREAE

Explanation of Plate

PLATE 14

Fig. 1. *Helicosporium aureum* (Cda.) Linder
The dark, erect, bristle-like conidiophores are shown with the lateral hyaline, bladder-like projections that bear 2 or more sporogenous teeth. The conidiophore on the left is more mature and has begun to branch in the manner characteristic of the species. × 500.

Fig. 2. *Helicosporium aureum* (Cda.) Linder
A slightly higher magnification of one of the bladder-like projections.

Fig. 3. *Helicosporium aureum* (Cda.) Linder
A secondary, fuscous, ovoid conidium formed on the terminal portion of an erect conidiophore. Slightly above and on the opposite side may be seen a projection from which a similar spore has fallen. From material growing on bark. × 500.

Fig. 4. *Helicosporium aureum* (Cda.) Linder
A germinating spore. × 1145.

Figs. 5–6. *Helicosporium aureum* (Cda.) Linder
Early stages in the formation of the dark perithecium-like bodies. From van Tieghem cell culture. × 500.

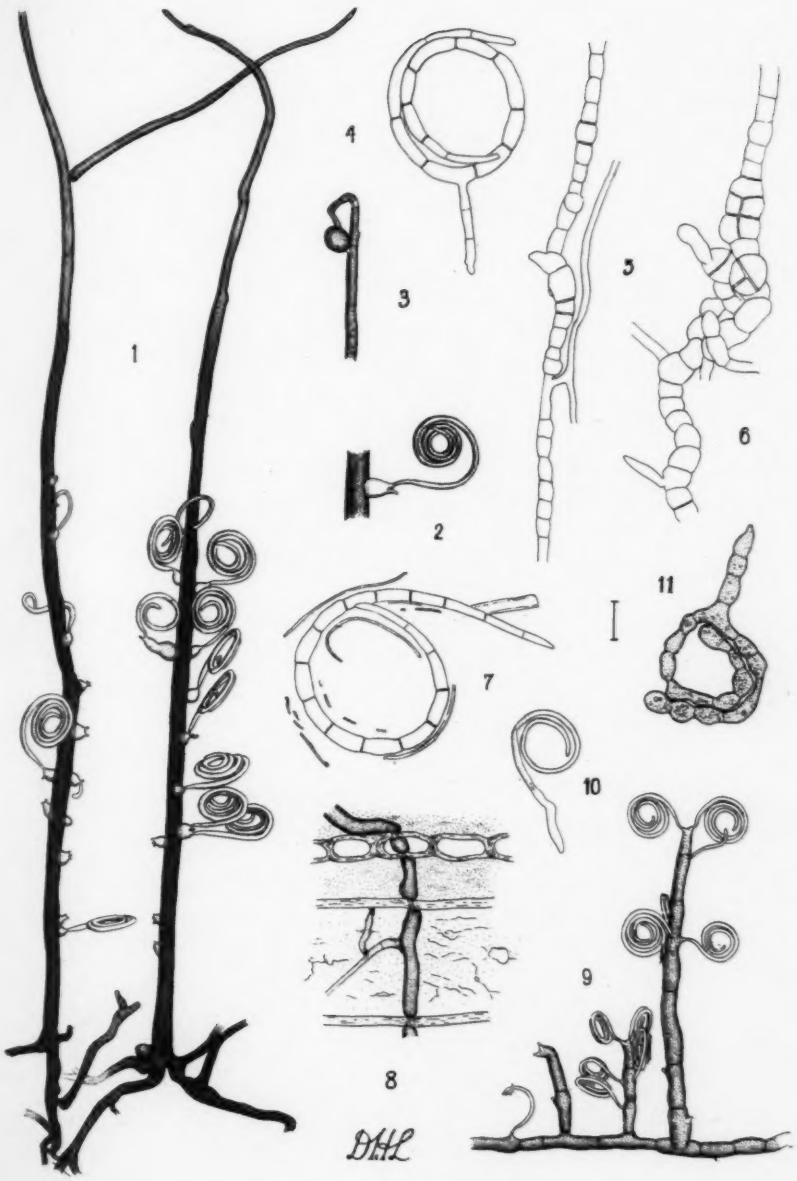
Fig. 7. *Helicosporium aureum* (Cda.) Linder
A spore which, swelling in preparation for germination, has ruptured its yellow exospore. × 1145.

Fig. 8. *Helicosporium aureum* (Cda.) Linder
Penetration of the substratum by a vegetative hypha. × 500.

Fig. 9. *Helicosporium gracile* (Morgan) Linder
Upright conidiophores that arise from the creeping fertile hyphae. × 500.

Fig. 10. *Helicosporium gracile* (Morgan) Linder
A spore germinating by the elongation of the terminal cell, a method characteristic of this species. × 500.

Fig. 11. *Helicosporium gracile* (Morgan) Linder
The germination of a spore after one month at 98.9 per cent relative humidity. Note the dark color and the bulging cell walls. × 500.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EXPLANATION OF PLATE

PLATE 15

Figs. 1–2. *Helicosporium decumbens* Linder

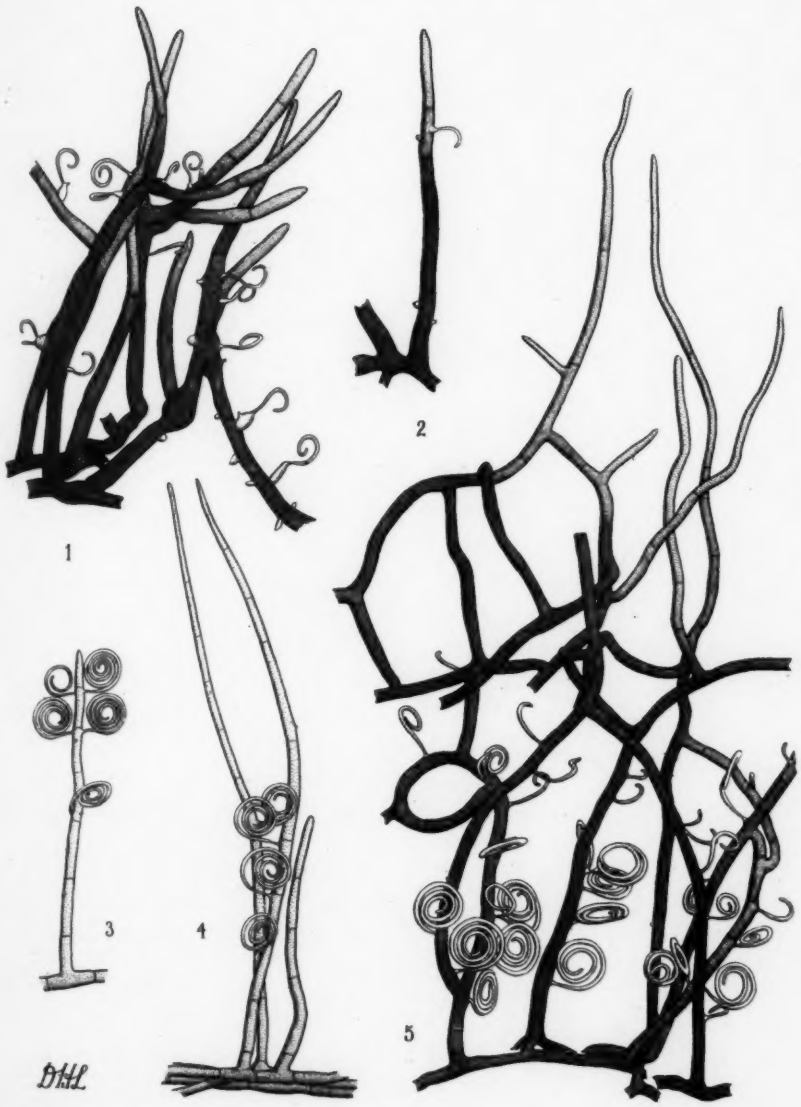
Conidiophores and conidia. The conidiophores are rather short, slightly bulging occasionally, and almost horizontally branched above in the older material. The conidia are produced either on simple minute teeth or else on inflated, bladder-like lateral projections of the conidiophores. Drawings from type material. × 500.

Figs. 3–4. *Helicosporium griseum* (Bonorden) Saccardo

Drawing from material collected by von Höhnel (Austria, Wienerwald). × 500.

Fig. 5. *Helicosporium lumbricoides* Saccardo emend. Matruchot

The conidiophores of this material are typically much branched and repeatedly anastomosed. × 500.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Explanation of Plate

PLATE 16

Fig. 1. *Helicosporium pallidum* Ces.
The upper parts of the conidiophores have anastomosed with adjacent ones of the same species. Drawings from type material. × 500.

Fig. 2. *Acanthostigmella genuflexa* von Höhnel
The perithecial stage of *Helicosporium phragmites* with its characteristic curved bristles below the ostiole. Drawing from type material. × 275.

Fig. 3. *Acanthostigmella genuflexa* von Höhnel
Ascospores from type material. × 500.

Figs. 4–5. *Helicosporium phragmites* von Höhnel
The conidiophores of this species are stouter, more loosely branching, and more frequently septate than are those of *H. pallidum*. Drawings from type material. × 500.

Fig. 6. *Helicosporium lumbricopsis* Linder
An immature specimen that has not become branched. × 500.

LINDER—HELICOSPOREAE

EXPLANATION OF PLATE

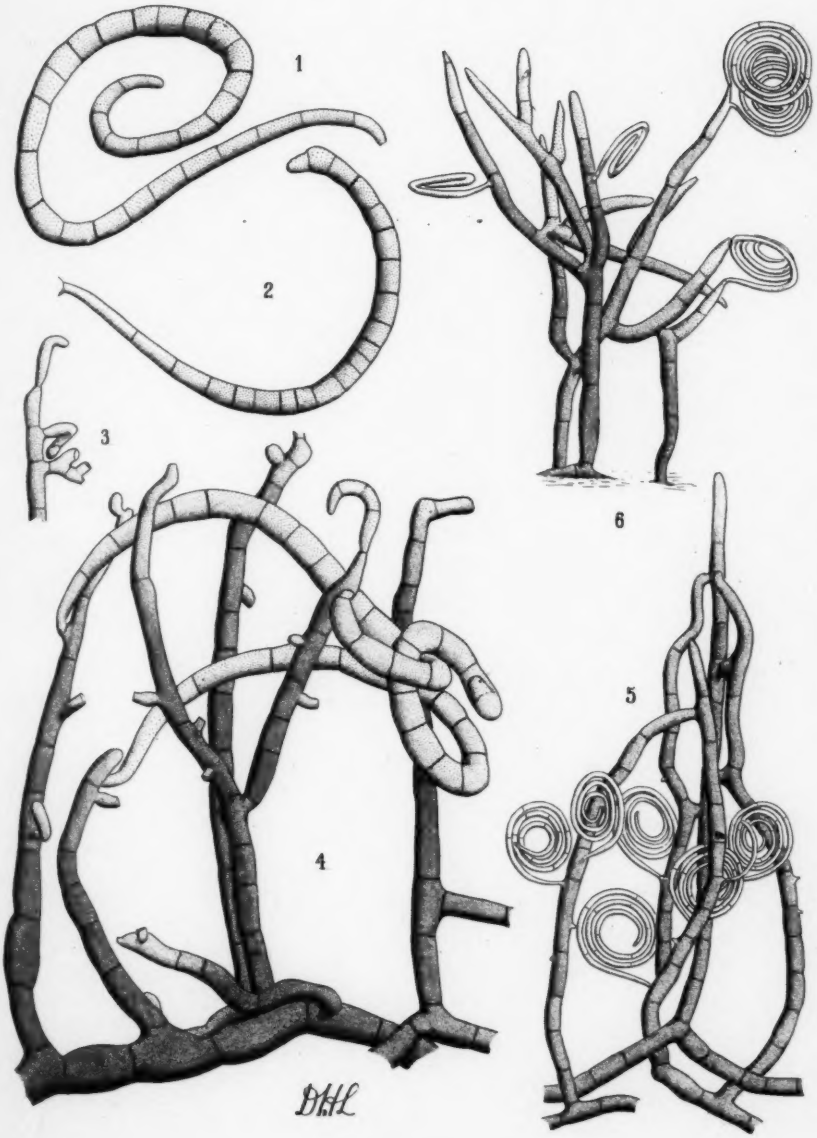
PLATE 17

Figs. 1–2. *Helicosporium serpentinum* Linder
Two immature conidia. Drawings from type material. × 500.

Fig. 3. *Helicosporium serpentinum* Linder
Tip of a conidiophore showing the stout sporogenous teeth and 2 very immature conidia. Drawing from type material. × 500.

Fig. 4. *Helicosporium serpentinum* Linder
Conidiophores with 2 mature conidia. Drawing from type material. × 500.

Figs. 5–6. *Helicosporium lumbricopsis* Linder
The two figures illustrate different types of branching, both of which may be present in the same colony. Fig. 5 drawn from type material. × 500.



LINDER—HELICOSPOREAE

Explanation of Plate

PLATE 18

Fig. 1. *Helicosporium nematosporum* Linder
A characteristic specimen from temperate regions (*Thaxter*, New Haven, Conn.). × 500.

Fig. 2. *Helicosporium nematosporum* Linder
"Sclerotes pedicelées" in association with the above material. × 500.

Fig. 3. *Lasiosphaeria nematospora* Linder
The perfect stage of *Helicosporium nematosporum* and found in connection with that species in the British Guiana material. Drawing from type. × 28.

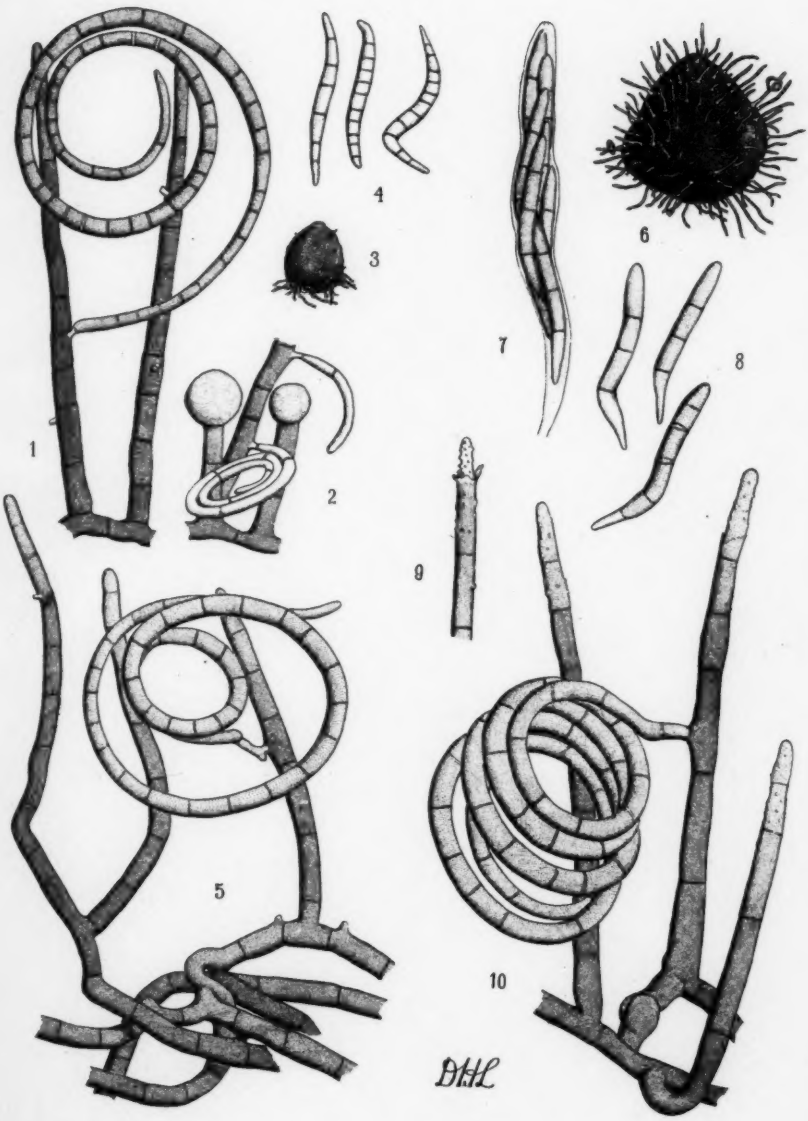
Fig. 4. *Lasiosphaeria nematospora* Linder
Ascospores from type material. × 500.

Fig. 5. *Helicosporium nematosporum* Linder
The conidiophores of this material from British Guiana are more abundant and less stiffly erect in the more developed specimens than are those of temperate specimens. × 500.

Fig. 6. *Lasiosphaeria Elinorae* Linder
The perfect stage of *Helicosporium Elinorae*. Some of the bristles on the perithecium, as is shown, frequently bear conidia. Drawing made from type material. × 28.

Figs. 7–8. *Lasiosphaeria Elinorae* Linder
Ascus and ascospores from the type material. The tapering basal cells of the ascospores are hyaline to subhyaline. × 500.

Figs. 9–10. *Helicosporium Elinorae* Linder
In fig. 9 is shown the end of a conidiophore, of which the colored outer sheath has been ruptured by the hyaline, tuberculate growing point. Fig. 10 illustrates typical conidiophores, of which one bears a dilute fuscous conidium that is coiled in 3 planes. Drawings made from type material. × 500.



LINDER — HELICOSPOREAE

Explanation of Plate

PLATE 19

Fig. 1. *Helicoma roseolum* Thaxter
The hyaline, branched, and anastomosed fertile hyphae are scandent on the dark conidiophores of another Fungus Imperfectus. From type material. × 500.

Figs. 2–3. *Helicoma roseolum* Thaxter
Conidia in optical section. Fig. 3 shows the unique method of attachment of the spores to the conidiophore. From type material. × 500.

Figs. 4–7. *Helicoma minutissimum* Linder
Conidiophores and conidia. Drawings from type material. × 1145.

Fig. 8. *Helicoma minutissimum* Linder
Conidia from type material. × 500.

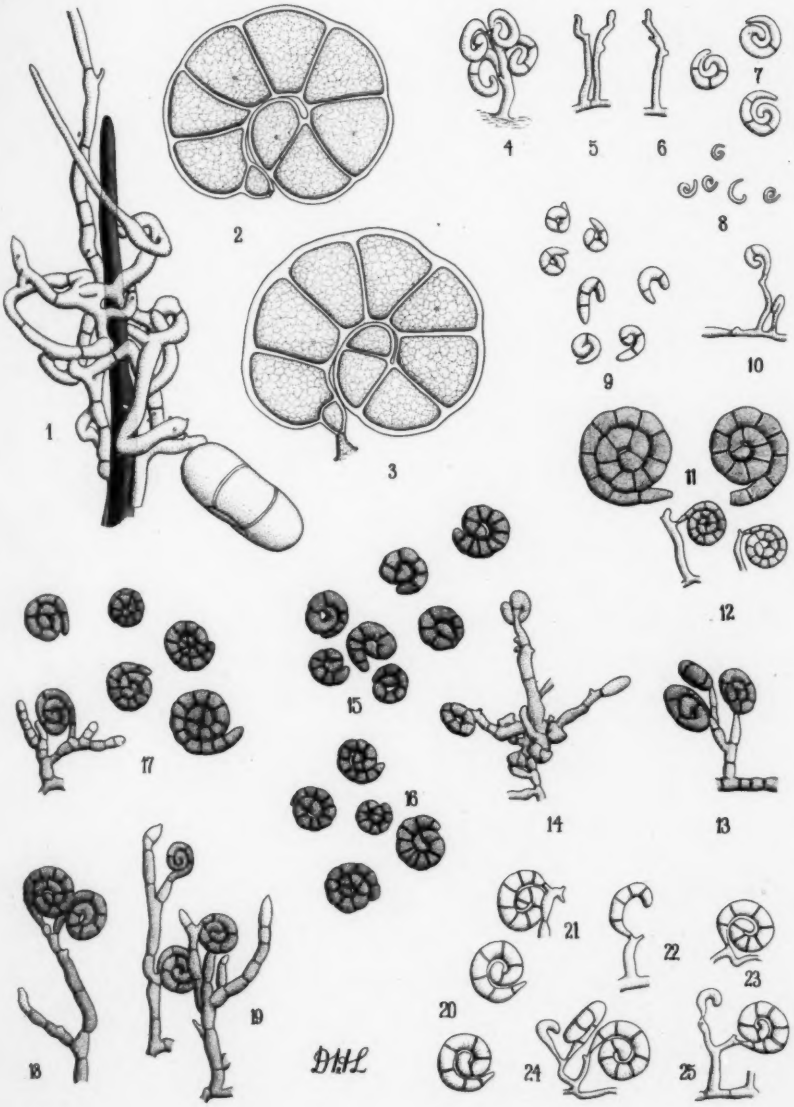
Figs. 9–10. *Helicoma stigmateum* (Reiss) Linder
Conidiophores and conidia. Drawing from material in Jaap, Fungi Selecti Exsiccati, the type of *Helicomyces niveus*. × 500.

Figs. 11–12. *Helicoma microscopicum* (Ellis) Linder
Drawings from type material. Fig. 11, × 1145; fig. 12, × 500.

Figs. 13–16. *Helicoma olivaceum* (Karsten) Linder
Figs. 13–15 are drawn from the type of *Helicopsis punctata* Pk., and fig. 16 from the type of *Helicopsis olivaceus* Karsten. × 500.

Figs. 17–19. *Helicoma monilipes* Ellis & Johnson
Drawings made from type material. × 500.

Figs. 20–25. *Helicoma polysporum* Morgan
Drawings made from type material. × 500.



LINDER—HELICOSPOREAE

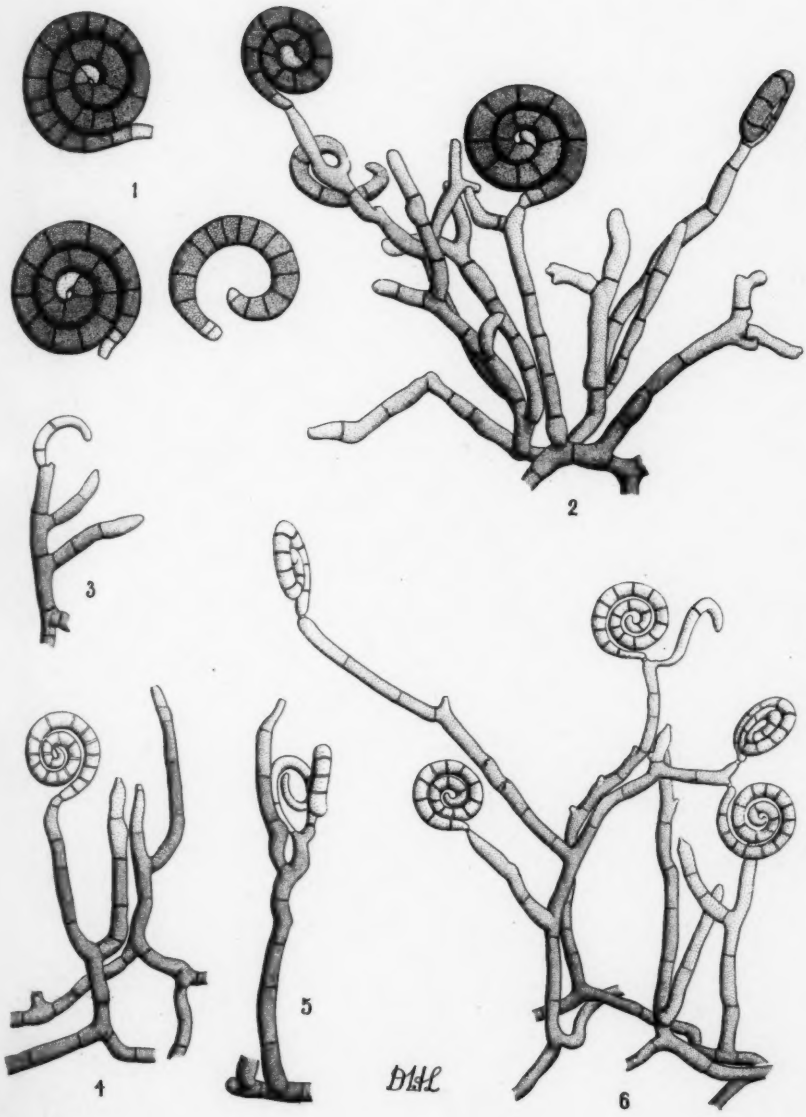
Explanation of Plate

PLATE 20

Figs. 1–2. *Helicoma perelegans* Thaxter
Conidiophores and conidia, the latter with subhyaline terminal cells. Drawings made from type material. × 500.

Figs. 3–5. *Helicoma violaceum* Winter
The conidia are attached obliquely to the conidiophores. Drawings made from type material. × 500.

Fig. 6. *Helicoma Morgani* Linder
Drawing made from type material. × 500.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Explanation of Plate

PLATE 21

Figs. 1–2. *Lasiosphaeria pezizula* (B. & C.) Saccardo

The gregarious perithecia are the perfect stage of *Helicoma Curtisii*. The still turgid perithecia are surmounted by the white to dilute brown mass of ascospores that has been exuded, while the dried perithecia have collapsed and become cup-shaped. × 28.7.

Figs. 3–4. *Lasiosphaeria pezizula* (B. & C.) Saccardo

Asci showing the thickening of the apices, and the arrangement of the 5–7-septate ascospores within. × 500.

Figs. 5–6. *Lasiosphaeria pezizula* (B. & C.) Saccardo

A single typical mature 7-septate ascospore is shown in fig. 5. Fig. 6 is of an ascospore germinating in a typical fashion by terminal hyphae which are followed by the lateral germ tube. From material in van Tieghem cells. × 500.

Fig. 7. *Helicoma Curtisii* Berkeley

The dark, simple, erect conidiophores are shown bearing single spores on the rounded, tapering apices. The inconspicuous lateral sporogenous teeth should be noted and compared with those of *Helicoma Mülleri*. × 500.

Fig. 8. *Helicoma Curtisii* Berkeley

The end of a conidiophore that has been turned to one side during elongation after the formation of the first spore. × 500.

Figs. 9–10. *Helicoma Curtisii* Berkeley

A conidiophore and conidia from type material. × 500.

Fig. 11. *Helicoma ambiens* Morgan.

Three conidia drawn from co-type material. The slightly stouter filaments and the short, abruptly rounded basal cell distinguish this species from *H. Curtisii*. × 500.

Fig. 12. *Helicoma Mülleri* Corda

The frequently septate conidiophores are shown with their bluntly rounded apices and the stout, pleurogenous, spore-bearing teeth. At *a* is shown a spore that has taken a lateral position as the result of elongation of the terminal cell, and at *b*, a spore-bearing tooth that has become branched. × 500.

Figs. 13–14. *Helicoma Mülleri* Corda

A single cell of a hypha that has turned brown previous to the formation of a conidiophore is shown in fig. 13. Fig. 14 represents a terminal portion of a hyphal branch that has darkened and resembles a conidiophore. From material growing in van Tieghem cells. × 500.

Figs. 15–18. *Helicoma Mülleri* Corda

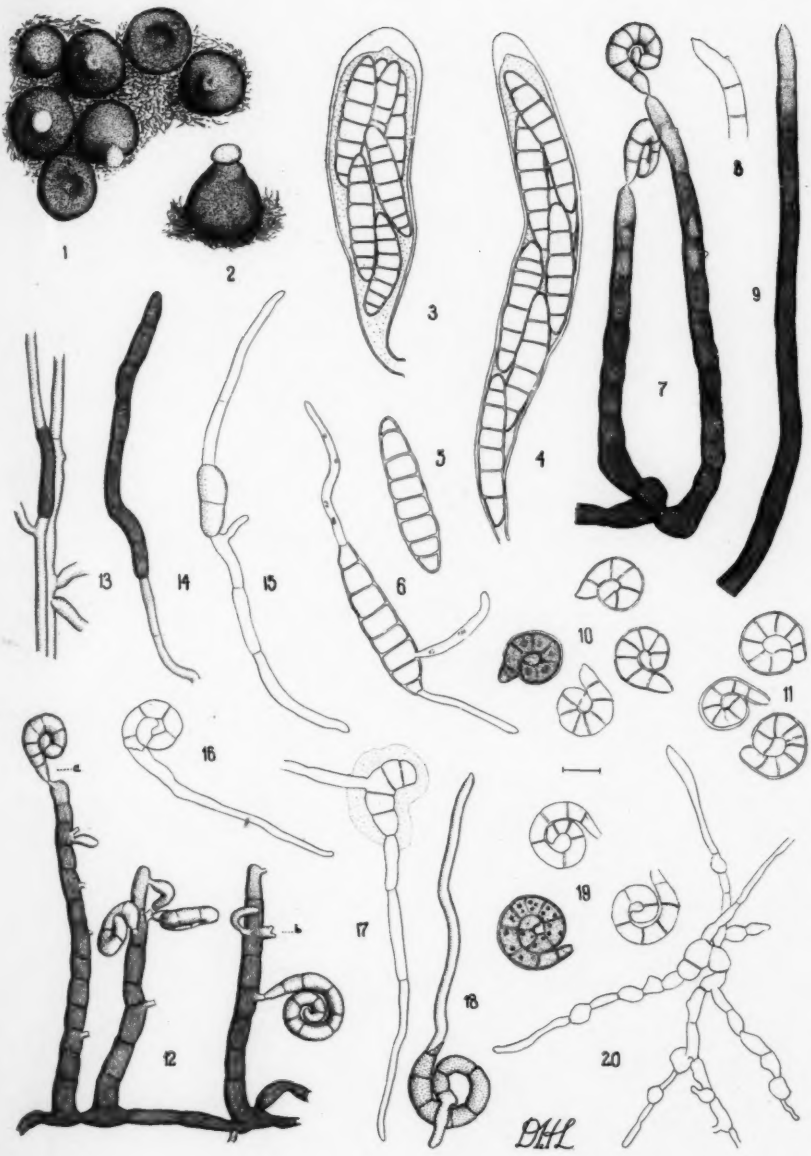
Figs. 15 and 16 are of immature spores that have germinated after having been exposed to freezing temperatures. The latter spore is surrounded by a thick gelatinous sheath. Figs. 16 and 18 demonstrate the germination of conidia by the rupturing of the exospore and the elongation of the basal cell. From material in van Tieghem cell cultures. × 500.

Fig. 19. *Helicoma Mülleri* Corda

A group of spores showing the tapering and truncate basal cells that immediately distinguish this species from *H. Curtisii*. × 500.

Fig. 20. *Helicoma Mülleri* Corda

A conidium that had been germinated at 100 per cent relative humidity and then transferred to 98.9 per cent relative humidity, after which it was allowed to grow for one month. Little growth has taken place, but the cells have become distinctly swollen. × 500.



LINDER—HELICOSPOREAE

Explanation of Plate

PLATE 22

Fig. 1. *Helicoma velutinum* Ellis
Drawings made from co-type material. × 500.

Fig. 2. *Helicoma phaeosporium* Fresenius
Drawings of spores from material collected by the writer at Canton, Mass. × 500.

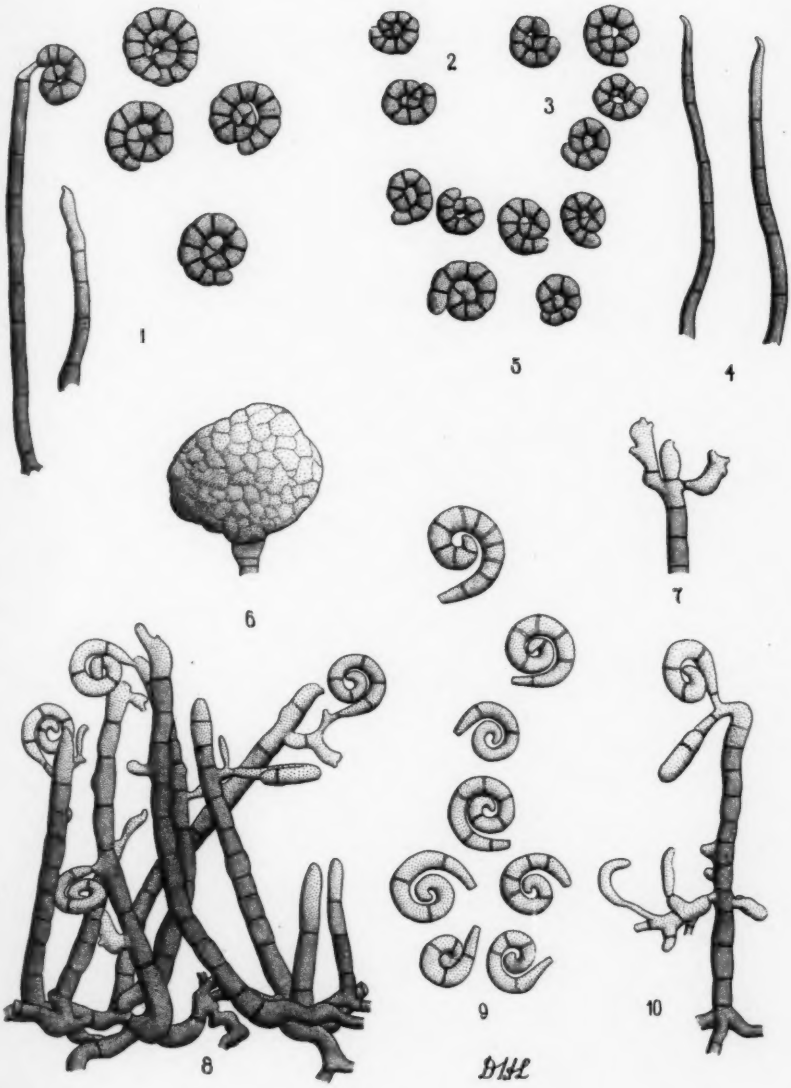
Figs. 3–4. *Helicoma phaeosporium* Fresenius
Drawings made from type of *Helicoma Boydii*. × 500.

Fig. 5. *Helicoma phaeosporium* Fresenius
Drawings made from the type of *Helicoma spectabile*. × 500.

Fig. 6. *Helicoma proliferens* Linder
"Sclerote pedicelée" associated with the conidial stage. From type material. × 500.

Fig. 7. *Helicoma proliferens* Linder
The terminal portion of a conidiophore bearing the stout, proliferating teeth. From type material. × 500.

Figs. 8–10. *Helicoma proliferens* Linder
Conidia and conidiophores. The conidia strongly resemble those of *H. Mülleri* in their tapering truncate basal ends. The conidiophores, however, because of the pronounced proliferation of the sporogenous teeth, are clearly different from those of *H. Mülleri*, as is shown especially clearly in fig. 10. Drawings from type material. × 500.



LINDER—HELICOSPOREAE

Explanation of Plate

PLATE 23

Figs. 1–3. *Helicoma ambiens* Morgan

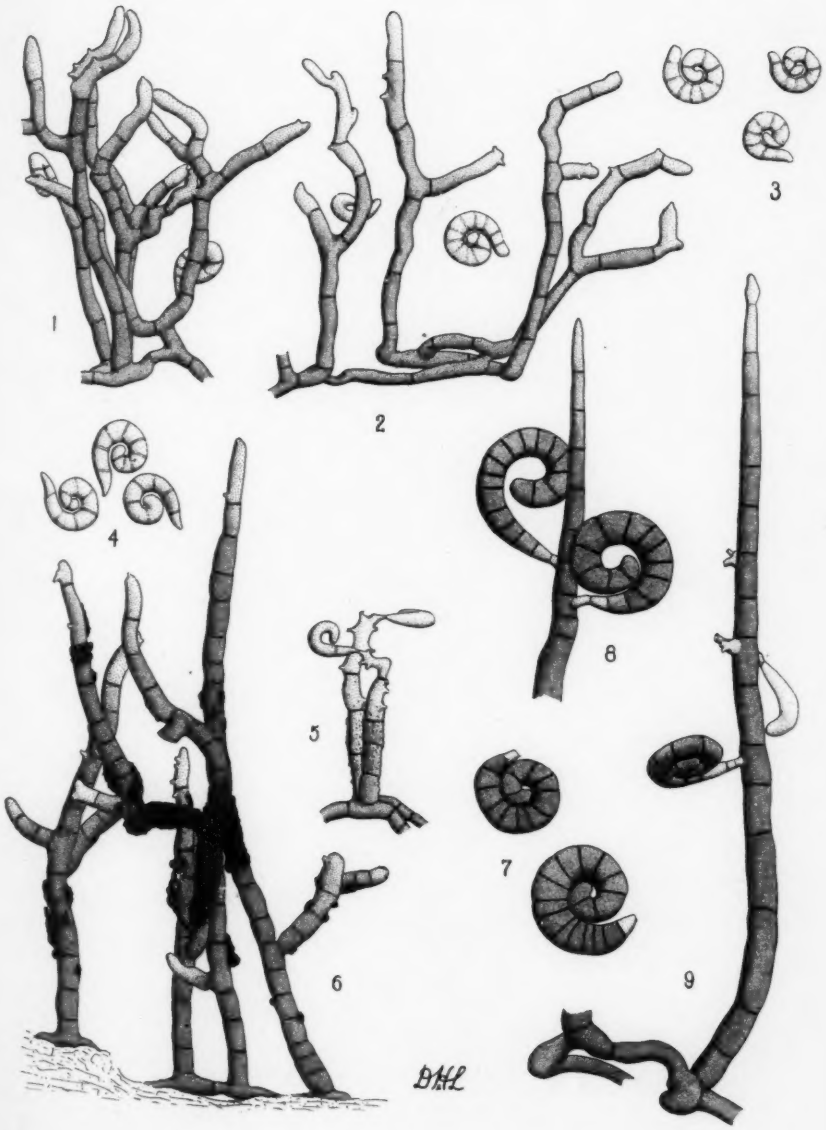
The abruptly rounded and slightly recurved basal ends of the conidia and the conspicuous branching of the conidiophores clearly separate this species from the closely related *H. Curtisii*. Drawings made from co-type material. × 500.

Figs. 4–6. *Helicoma asperothecum* Linder

Conidiophores and conidia. The rough sheath, characteristic of the species, is clearly shown in fig. 5. In the older material, fig. 6, purplish-black secretions are almost invariably present on the conidiophores. Drawings made from type material. × 500.

Figs. 7–9. *Helicoma atroseptatum* Linder

The stout conidia with black septa and subhyaline basal cells, and the simple erect conidiophores characterize this species. Drawings from type material. × 500.



LINDER—HELICOSPOREAE

Explanation of Plate

PLATE 24

Figs. 1–2. *Helicoma simplex* (Sydow) Linder

Conidiophores and conidia. Conidiophores of this species are characterized by the presence of lateral swellings, on which conidia were previously produced. The conidia of this and *H. fasciculatum* are distinct in that at either side of the hyaline septa are distinct dark bands. Drawings from type material. × 500.

Figs. 3–4. *Helicoma fasciculatum* Berkeley & Curtis

The conidia of this species are slightly larger than those of *H. simplex*, and the conidiophores are longer, without the lateral projections. Drawings from type material. × 500.

Figs. 5–6. *Helicoma conicodentatum* Linder

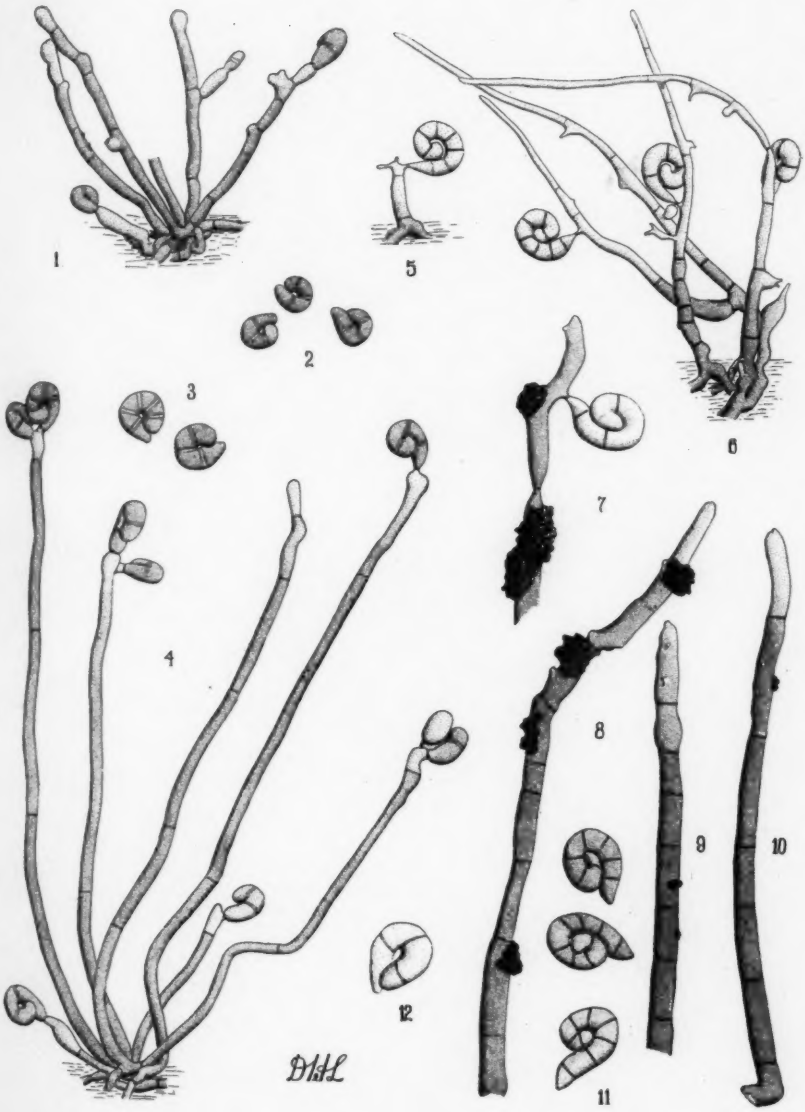
An immature spore-bearing conidiophore is shown in fig. 5. Fig. 6 shows more-mature conidiophores which have commenced to elongate and become scandent. On the subhyaline upper portions of the conidiophores, the conical teeth are clearly in evidence. Drawings from type material. × 500.

Figs. 7–11. *Helicoma recurvum* (Petch) Linder

The stout, tightly coiled conidia, the constrictions in the terminal portions of the conidiophore, and the usual presence of dark crystal deposits separate this species from *H. Curtisii*. Drawings from type material. × 500.

Fig. 12. *Helicoma candidum* (Preuss) Linder

A single conidium from the type material. Compare this with the text figure. × 500.



LINDER—HELICOSPOREAE

Explanation of Plate

PLATE 25

Figs. 1–5. *Xenosporella pleurococca* von Höhnel

The hyaline or subhyaline conidiophores and the subhyaline terminal cells of the conidia mark this as a distinct species. The series of figures illustrate stages in the formation of the mature conidia. Unfortunately, the origin of the peculiar central cell could not be observed. Drawings from type material. × 500.

Figs. 6–11. *Xenosporella Berkeleyi* (Curtis) Linder. All × 500.

Figs. 6, 7. Drawings from type material of *Helicoma Berkeleyi*.

Fig. 8. A single spore from material erroneously identified as *H. velutinum*. (*Langlois*, on dead *Vitis vulpina*, Louisiana).

Fig. 9. Two spores from the type material of *H. diplosporum*.

Fig. 10. Four spores, 2 between figs. 6 and 7, from the type material of *H. bambusae*.

Fig. 11. Conidia and conidiophores from the type material of *H. Berkeleyi*.

Figs. 12–15. *Xenosporella larvalis* (Morgan) Linder

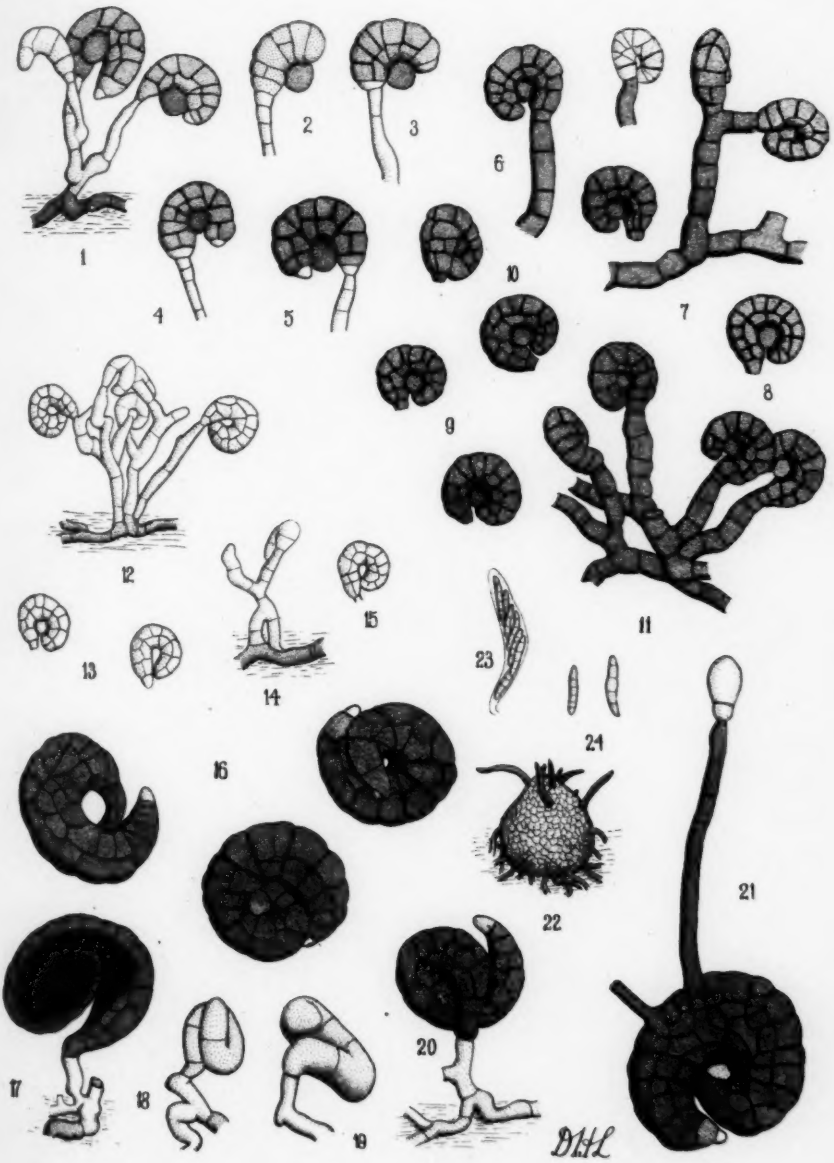
Conidiophores and conidia from type material.

Figs. 16–21. *Xenosporella Thaxteri* Linder

Conidia and conidiophores. The sterile mycelium becomes deep fuscous a short distance from the conidiophores, and when seen under the hand lens is black and glistening. Figs. 18 and 19 show 2 immature conidia, while fig. 21 illustrates a mature conidium giving rise to a secondary spore form. Drawings from type material. × 500.

Figs. 22–24. *Acanthostigmella Thaxteri* Linder

A perithecial stage in association, although not definitely connected, with the conidial stage of *Xenosporella Thaxteri*. Figs. 23 and 24 represent an ascus and ascospores. Drawings from type material. × 500.



LINDER—HELICOSPOREAE

Explanation of Plate

PLATE 26

Figs. 1–2. *Helicoon farinosum* Linder

Conidiophores and conidia. The short, almost ovoid conidia with their definite septa and the usually distinct conidiophores separate this species from *H. sessile*, which it closely resembles. Drawings from type material. × 500.

Figs. 3–5. *Helicoon auratum* (Ellis) Morgan

Conidia and conidiophores. The conidiophores, fuscous below and dilute fuscous above, usually bear the golden-yellow spores one at a time, although, as is indicated by the presence of sporogenous teeth, they are capable of producing several conidia. Fig. 5 demonstrates the hygroscopic nature of the spore by its slight uncoiling and pronounced elongation. × 500.

Figs. 6–8. *Helicoon fuscosporum* Linder

Conidiophores and conidia from type material. × 500.

Figs. 9–10. *Helicoon reticulatum* Linder

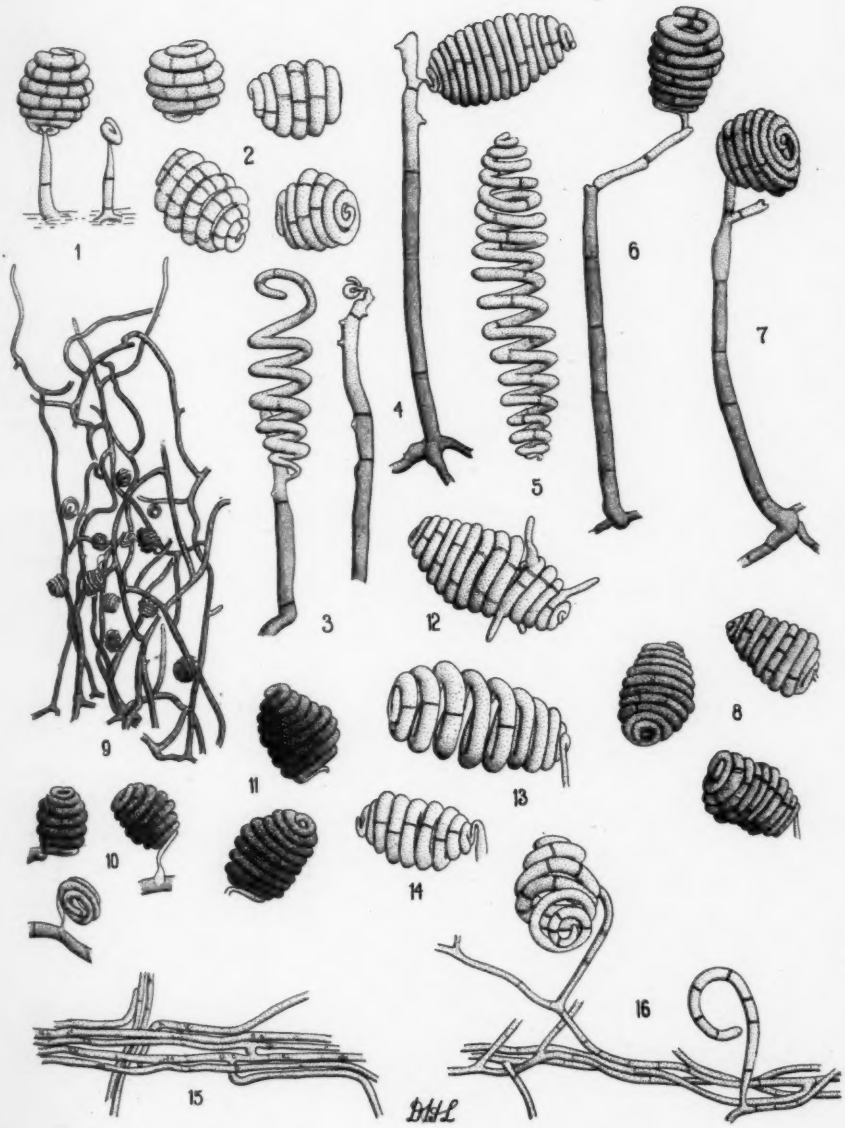
The conidiophores of this species are comparable to those of *Helicosporium lumbricoides* in that they branch and anastomose frequently, as is true also of *Helicoon ellipticum*. Drawings from type material. × 500.

Fig. 11. *Helicoon ellipticum* (Peck) Morgan

The conidiophores not shown here are the same as those of *H. reticulatum*. The conidia of this species are, however, conspicuously larger than are those of *H. reticulatum*. × 500.

Figs. 12–16. *Helicoon sessile* Morgan

In fig. 12 is shown a germinating conidium. Figs. 15 and 16 are both drawn from material in culture. Fig. 15 shows a portion of a strand of parallel hyphae which apparently serve for the transportation of food material and of retaining moisture, as is explained in Part I of the text. All drawings from material collected by the writer. × 500.



LINDER—HELICOSPOREAE

EXPLANATION OF PLATE

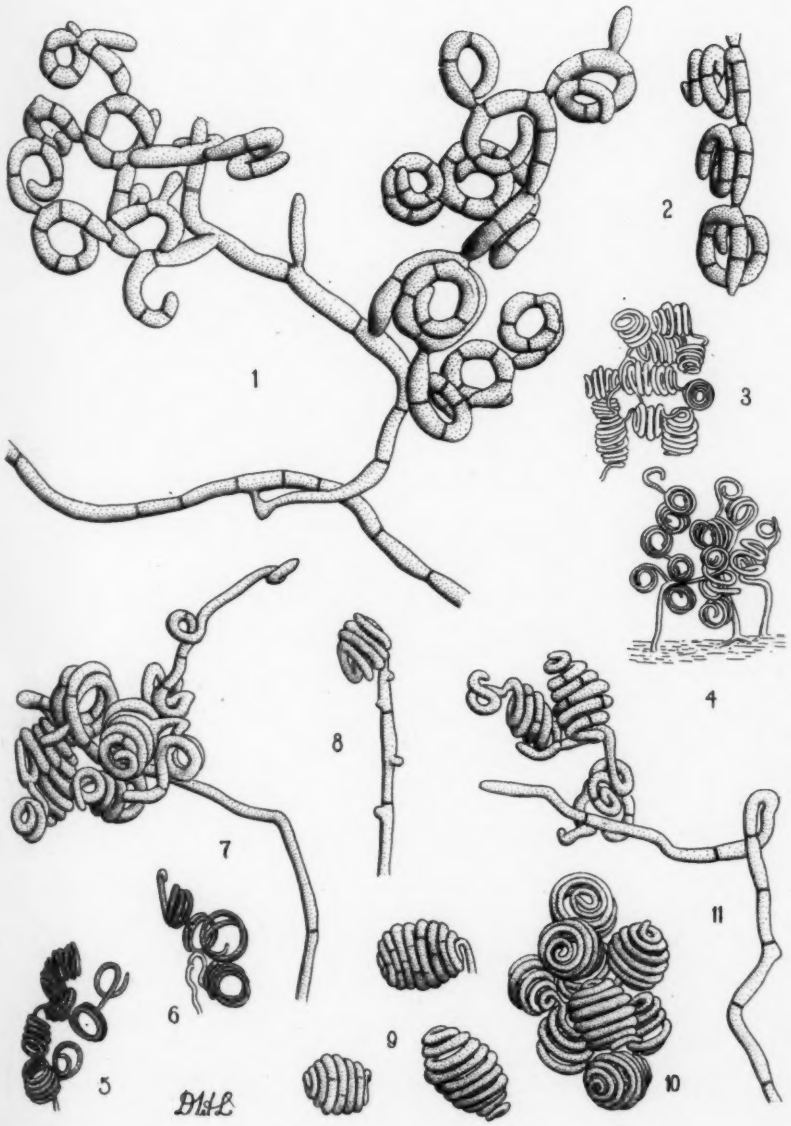
PLATE 27

Figs. 1–2. *Helicodendron triglitziensis* (Jaap) Linder
In fig. 1 is shown a conidiophore which has arisen from the repent sterile mycelium and bears two groups of conidia that produce tangled chains. Fig. 2 is an edgewise view that illustrates the seriate arrangement of the conidial coils. × 500.

Figs. 3–4. *Helicodendron hyalinum* Linder
Conidia and conidiophores from type material. × 500.

Figs. 5–6. *Helicodendron fuscum* (B. & C.) Linder
Conidia and conidiophores from type material. × 500.

Figs. 7–11. *Helicodendron tubulosum* (Reiss) Linder
Conidia and conidiophores. The drawings represented by figs. 7 and 11 are both from specimens growing in culture, the remainder are from specimens growing on the natural substratum. × 500.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Explanation of Plate

PLATE 28

Fig. 1. *Hobsonia mirabilis* (Peck) Linder

A section through a sporodochium showing the rather compact arrangement of the hyphae, and the conidia borne at or near the surface of the colony. Drawing from material growing on corncob in Tennessee. × 120.

Figs. 2–5. *Hobsonia mirabilis* (Peck) Linder

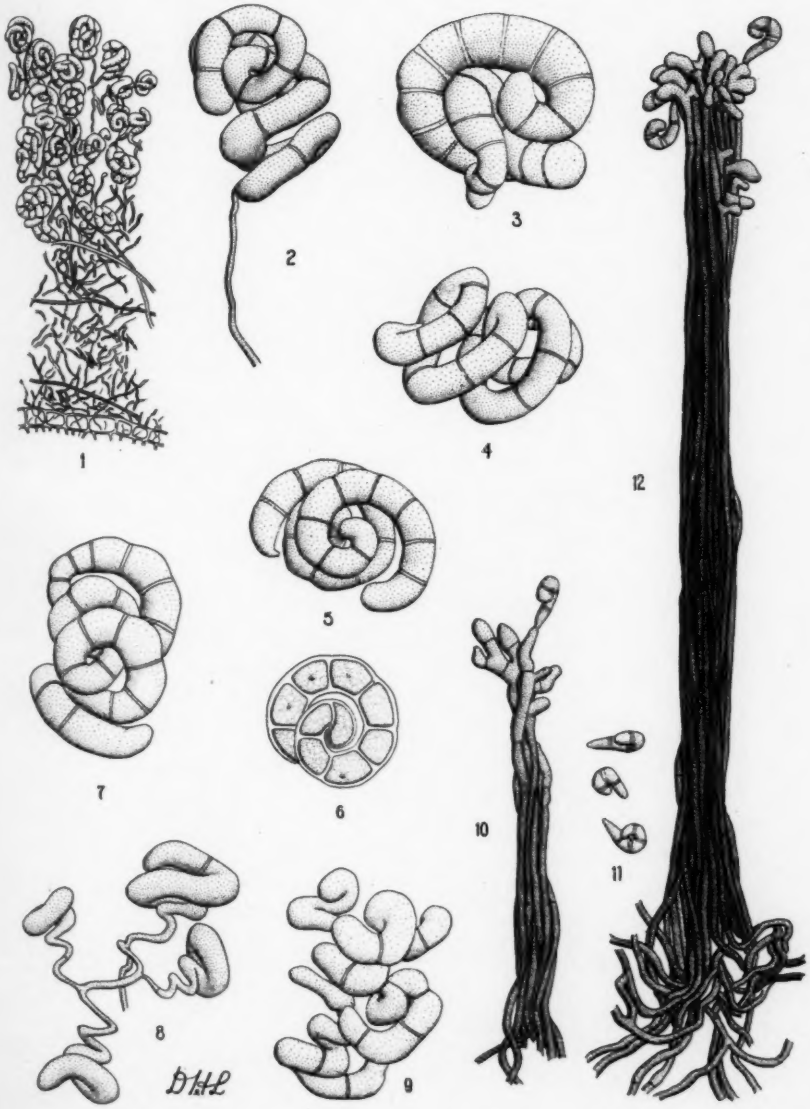
Conidia. In fig. 2 the simple and but slightly twisted conidiophore is shown, and in fig. 5, a conidium which has begun to proliferate. × 500.

Figs. 6–9. *Hobsonia gigaspora* Berkeley

Figs. 6 and 7 represent simple conidia; fig. 8 illustrates the branching and spiral twisting of the conidiophores just below the conidia; while in fig. 9 is shown a proliferating conidium. All the drawings were made from material collected in Grenada (*Thaxter*, Grand Etang, Grenada). × 500.

Figs. 10–12. *Helicostilbe simplex* Petch

The conidiophores, as shown in figs. 10 and 12, are closely aggregated to form synnemata which bear the sporogenous teeth apically. The conidia of this species strongly resemble those of *Helicoma simplex* and *Helicoma fasciculatum*. Drawings from type material. × 500.



LINDER—HELICOSPOREAE

Explanation of Plate

PLATE 29

Fig. 1. *Everhartia lignitalis* Thaxter
A substipitate sporodochium. The rounded mass at the summit is composed of spores that are held together by the gelatinous matrix in which they are imbedded. Freehand drawing from type material. × 22.5 approx.

Fig. 2. *Everhartia lignitalis* Thaxter
Conidiophores from apex of sporodochial stipe. Preparation obtained by crushing the material on the object glass. × 500.

Figs. 3–4. *Everhartia lignitalis* Thaxter
The conidia in fig. 3 are shown in optical section, × 1145; those in fig. 4, × 500.

Fig. 5. *Everhartia candida* Thaxter
A pulvinate sporodochium. Freehand drawing from type material. × 22.5 approx.

Figs. 6–7. *Everhartia candida* Thaxter
The conidia in fig. 6 are shown in optical section, × 1145; those in fig. 7, × 500.

Figs. 8–9. *Everhartia hymenuloides* Saccardo & Ellis
The conidium in fig. 8 is shown in optical section, × 1145; those in fig. 9, × 500. From type material.

Figs. 10–14. *Troposporella fumosa* Karsten
Conidia and conidiophores are shown in figs. 10 and 12–14, all × 500. In fig. 11 the sporodochium with its dry granular surface is shown, × 20. All drawings are made from type material.

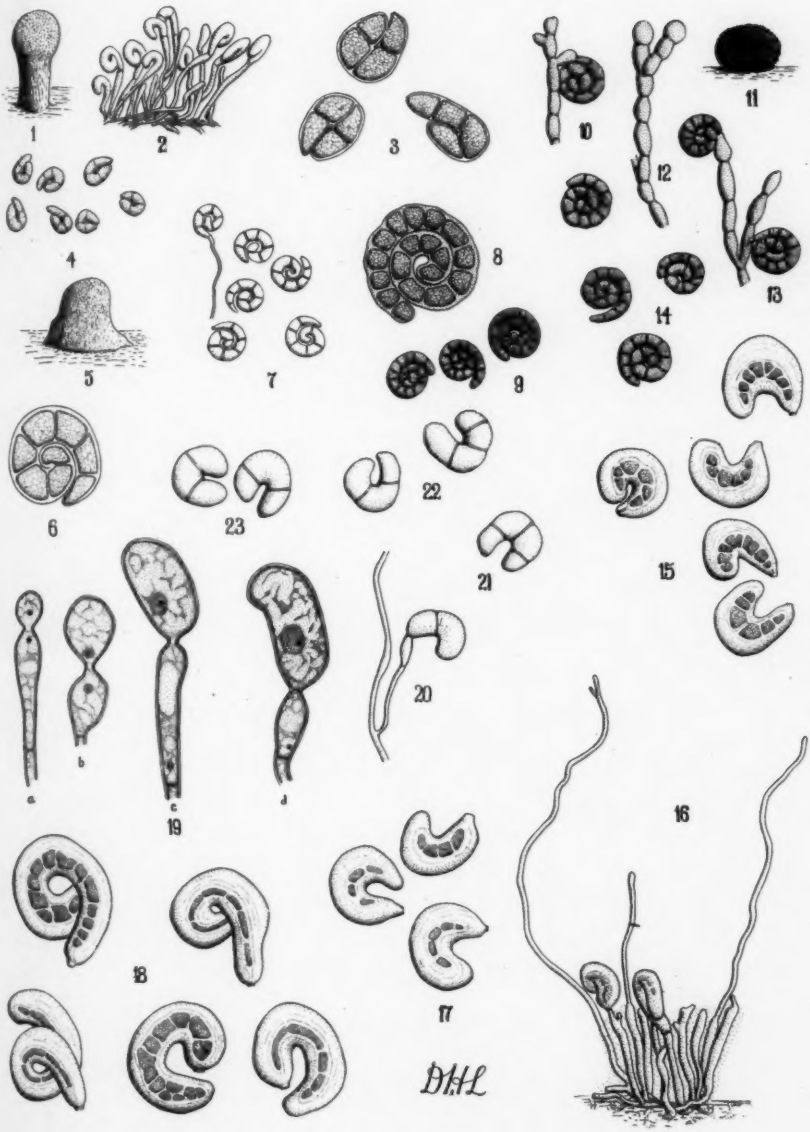
Figs. 15–17. *Drepanoconis larvaeformis* Spegazzini
In fig. 15, the drawings are of conidia from the type material of *Drepanoconis fructigena* (*Rick, 42*). Figs. 16 and 17 are from the type material of *D. larvaeformis* (*Balansa, 3758*). The conidiophores, as shown in fig. 16, are surrounded by a gelatinous hyaline matrix, and are much exceeded in length by the sterile hyphae. All figures × 500.

Fig. 18. *Drepanoconis anguisporus* Patouillard
Conidia from type material. × 500.

Fig. 19. *Delortia palmicola* Patouillard
Early stages in the formation of a conidium to show the behavior of the nuclei. × 1145.

Figs. 20–21. *Delortia palmicola* Patouillard
Conidia and a conidiophore with a portion of a sterile hypha. From Liberian material. × 500.

Figs. 22–23. *Delortia palmicola* Patouillard
Conidia from British Guiana material. × 500.



LINDER—HELICOSPOREAE

EXPLANATION OF PLATE

PLATE 30

Fig. 1. *Helicoma Curtisii* Berkeley
The spores are shown just previous to germination, at which time the filaments have become swollen and the exospore has been ruptured.

Fig. 2. *Helicomyces scandens* Morgan
Swollen conidia that have ruptured the exospores, fragments of which may be seen near the lower conidium.

Fig. 3. *Helicosporium aureum* (Cda.) Linder
Hygroscopic spores, some of which have uncoiled on contact with the wet agar substratum.

Fig. 4. *Helicodendron triglitziensis* (Jaap) Linder, and *H. tubulosum* (Reiss) Linder
Comparative cultures of 2 species. The flask on the right contains a colony of *H. tubulosum*, that on the left a colony of *H. triglitziensis*, and in the center the two species are contrasted.

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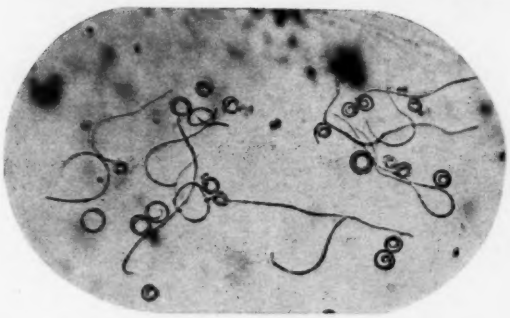

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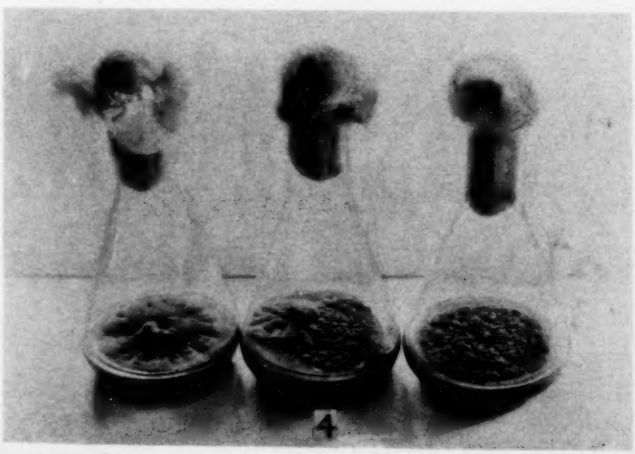

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LINDER—HELICOSPOREAE

COCKAYNE, BOSTON

Explanation of Plate

PLATE 31

Fig. 1. *Hobsonia mirabilis* (Peck) Linder
Sporodochia on a corncob. The white arrows point to a few of the sporodochia. × 1.2.

Fig. 2. *Helicoma Curtisii* Berkeley
The dark, effuse, hirsute colonies growing on decaying wood. × 1.2.

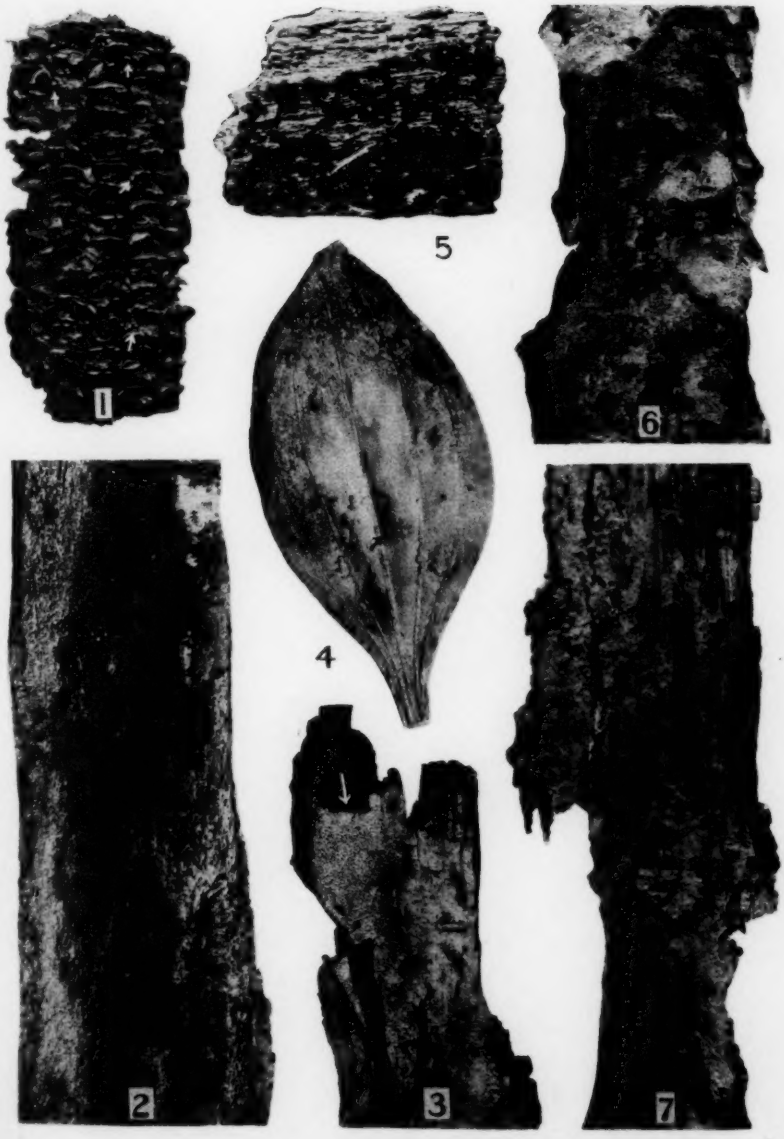
Fig. 3. *Helicomyces scandens* Morgan
The effuse and non-fasciculate younger portions of the colony are at the right, while the older part, indicated by the arrow, are characterized by denticulate appearance. It is in this older part that the hyphae have become fasciculate and the setae have developed. × 1.2.

Fig. 4. *Gyroceras plantaginis* (Cda.) Sacc.
Not included in the present paper.

Fig. 5. *Helicoon ellipticum* (Peck) Morgan.
The colonies are loose, cottony, and easily separable from the substratum of decaying wood. At first they are circular but tend to coalesce to form irregular masses. × 1.2.

Fig. 6. *Helicoma proliferens* Linder
The dark, circular, minutely hirsute colonies of this species apparently grow best near the lenticels in the bark. × 1.2.

Fig. 7. *Helicosporium lumbricoides* Sacc. emend. Matruchot
The colonies form an effuse cottony layer over the substratum. The light color is due to the hyaline to subhyaline extremities of the conidiophores and the abundance of conidia. × 1.2.



LINDER—HELICOSPOREAE

COCKAYNE, BOSTON